MACHINE DESIGN

February 1952

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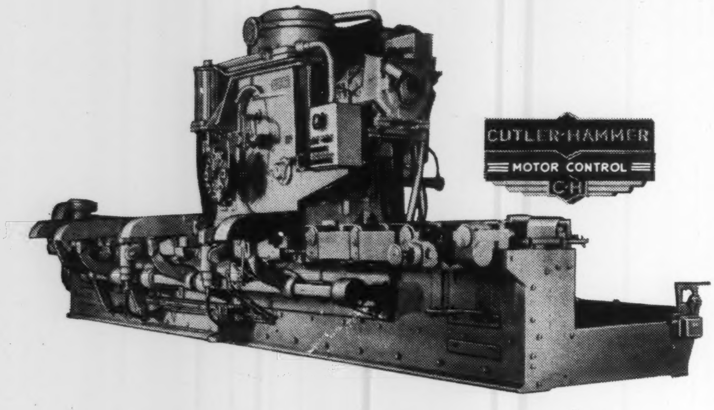

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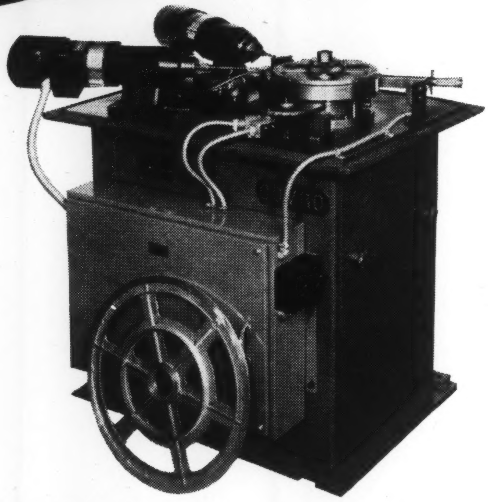

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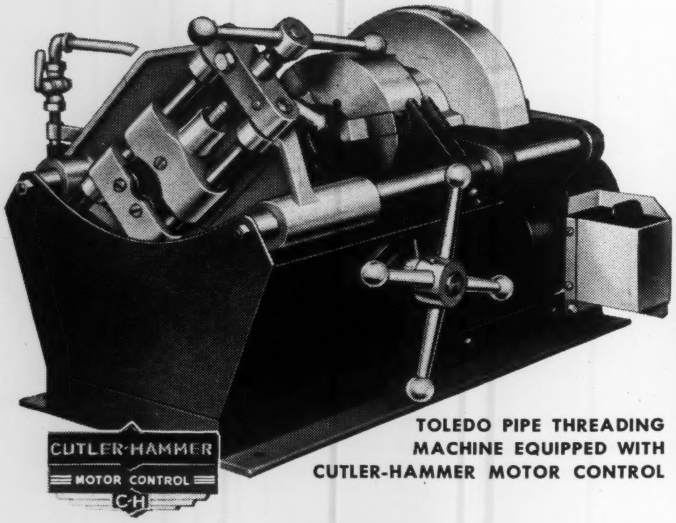

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MACHINE DESIGN

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Vol. 24—No. 2 **February 1952**

Challenge for the Future! (Editorial) 111

Power Brush Finishing—factors in selection and application 112
By V. K. Charvat and R. C. Sasena

Scanning the Field for Ideas 122
Low-inertia memory unit—adjustable-speed drives—cool grinding—breadboard design components—vapor cooling

Patentability of Combinations—standards imposed by U. S. Courts 125
By Ray D. Henson

Thread Locking with Plastics 127
By S. S. Stivala

Vibration Isolator—designed to provide uniform protection 132
By J. S. Zimmer

Contemporary Design 136
Bending machine—jet rotor grinder—wet blaster—paper punch—ice cube maker—carton former—Magnaflux tester

Protective Finishes—phosphate coatings—Part 2 141
By Norman P. Gentieu

Mechanisms for Intermittent Motion—Part 3 146
By Otto Lichtwitz

Plastics Components (Production and Design) 156

Stroboscope Tachometer—flywheel marking design 157
By Alvin B. Kaufman

Beam Deflection (Data Sheet) 161
By W. L. Tryon

Design Abstracts 172
Practical dimensioning—inelastic properties of metals—designing for human requirements

Over the Board 4
Topics 106
New Parts and Materials 175
Enginering Dept. Equipment 188
Helpful Literature 191
Men of Machines 208
The Engineer's Library 214
Noteworthy Patents 218
Report on Materials 224
News of Manufacturers 254
Society Activities 262
Sales and Service Personnel 268
Sales Notes 280
Meetings and Expositions 286
New Machines 290

Itemized Index 7

DESIGN FOR PRODUCTION • STYLING • MATERIALS SPECIFICATION • DESIGN ANALYSIS • MACHINE COMPONENTS • ENGINEERING MANAGEMENT

Over the Board

A New Field for Plastics

Through our good friends the American Cyanamid Co. we learned about the novel method of thread locking described in the article which begins on Page 127 of this issue. The method, which involves simply filling the space between nut and bolt threads with a suitable plastic, has the unique advantage of permitting control of torque resistance to loosening simply by changing the composition of the plastic. Oddly enough the plastic does not act as an adhesive but simply as an interference to increase the tightness of the fit.

Speaking of plastics, we hope to see some of you at the forthcoming plastics show in Philadelphia, March 11 to 14. Machine Design will have a small booth with some interesting exhibits and a few chairs which you are cordially invited to use when the dogs start barking.

This Month's Cover

Intermittent mechanisms, the subject of the current series of articles by Otto Lichtwitz, inspired the design of this month's front cover. Penton artist George Farnsworth has selected several typical mechanisms that are illustrated in the articles and grouped them into a pleasing design, with a background curve to suggest output motion analysis. Incidentally, demand for tear sheets of the intermittent mechanisms articles is running high. Don't delay sending in your post card if you want a copy of the current installment.

MACHINE DESIGN

Power Brushing

More and more attention is being focused on surface refinement both for improving fatigue life and for lowering cost of production. Actually, extremes in surface finish too often are specified without consideration of the methods of attainment. The possibilities of power brushing for this purpose have been rather obscure but during recent years tremendous advances have been made. To bring you the practical details of this method in one integrated and useful article, we have worked closely with the engineers of the Osborn Mfg. Co. Result is the outstanding "first" which begins on Page 112. Here you will find not only practical guidance on selection of brushes and brushed finishes but also vital details concerning the design of machines for brushing operations.

Jerk or Jolt?

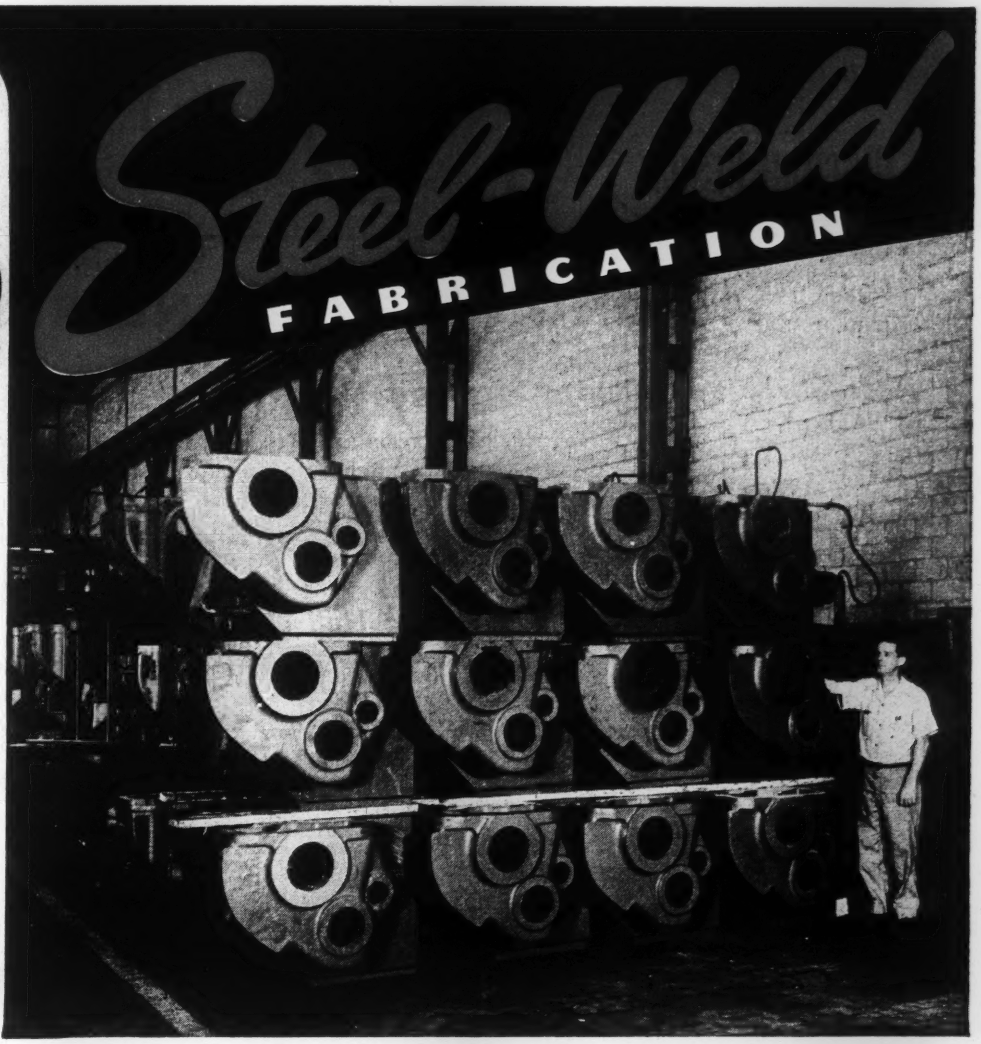
A few months ago we published a brief article on Cam Dynamics (March 1951) in which the term "jerk" was used to denote rate of change of acceleration. A little checking on the side revealed that this inelegant, unscientific-sounding word has considerable acceptance among engineers concerned with cam design. Now we find that the Air Force is using the term "jolt" to describe the same quantity — specifically, the rate of change of deceleration in tests to determine the effect on humans of sudden stops. It seems that the peak acceleration or deceleration (g's) that the body can safely withstand is limited by the jolt factor (g's per second) as much as by g itself.

Some day, presumably, one of these ungraceful words will receive official sanction like "slug," the engineering unit of mass. Right now it looks like an even race but, jerk or jolt, we don't like it in a Pullman berth in the middle of the night.

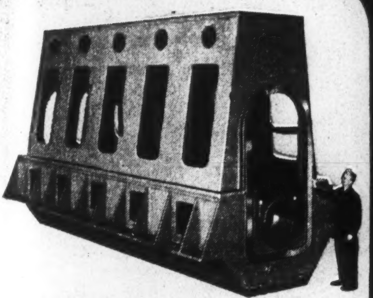
Too Many Office Parties?

Around the holiday season we kept hearing that the traditional office party was on the wane. Too many indiscretions had to be lived down for the rest of the year. Well, certain evidence which we have seen suggests that the office party is by no means dead. A quick glance at the incoming return post cards requesting copies of articles tells us that. It couldn't be coincidence that so many of the cards mailed between December 21 and 31 lacked the information we need in order to send you the material—your name and address! Who says engineers aren't human?

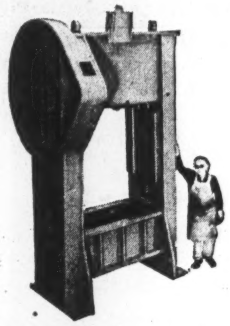
If therefore at this time, or any other, you do not receive the articles you want within a reasonable time, please let us know. We make it a point to acknowledge every request whether or not we can fill it, up to the expiration date printed on the post card.



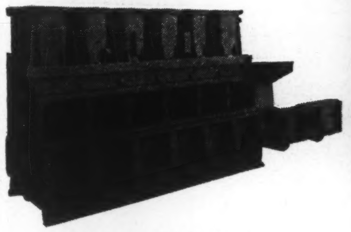
Steel-Weld FABRICATION



Crank Cases, Frames, and other Parts for Manufacturers of Marine Steam Engines of Uniflow or Multiple Expansion Type.

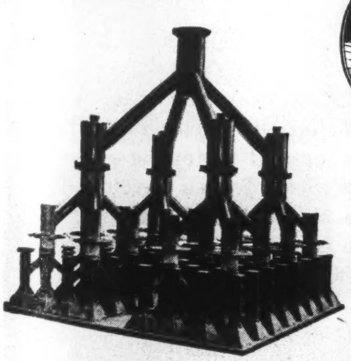


Heavy Press and Machine Frames and Bases for the Machine Tool Industry.



Diesel Engine Crank Cases and Frames for the Marine and Electro-Motive Field.

Pressure Vessels for the Chemical and Allied Industries.



One of Several Parts of a Catalytic Cracking Plant Produced for the Petroleum Industry.

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Mass production of these massive clutch and drive housings for a twenty-one ton tractor is further evidence of the design trend in modern machines . . . it is a typical example of how alert manufacturers are today employing Steel-Weld Fabrication to good advantage in the construction of their products. Thousands of such heavy machinery parts and assemblies are now produced and machined by Mahon for many manufacturers throughout the country. If savings in either cost or time can be effected in your product through Steel-Weld Fabrication of parts, or, if you are cramped for manufacturing space, it will pay you to investigate Mahon facilities. You will find in the Mahon organization an unique source with complete, modern fabricating, machining and handling facilities for any type of work regardless of size or weight . . . a source where skillful designing and advanced fabricating technique are supplemented by craftsmanship which assures you a smoother, finer appearing job embodying every advantage of Steel-Weld Fabrication.

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MACHINE DESIGN
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TOPICS

. . . IN ENGINEERING AND RESEARCH

New Carbide Eliminates Strategic Metals

Having high resistance to abrasion, erosion, corrosion and oxidation, recently developed chrome carbide is expected to supplant tungsten carbide in many applications. Produced by the Carboloy Dept. of GE, the new carbide is made from powdered metals, contains no critical tungsten or cobalt, and is completely nonmagnetic.

36-foot Landing Craft Has Plastic Hull

The largest plastic boat yet developed is the Navy's new LCVP landing craft. The 36-foot boat is of one-piece double-hull construction made up of glass fiber cloth impregnated with a polyester resin. Fitted with a steel landing ramp and armor for troop protection, the boat is powered by a conventional 225-hp marine engine in a steel-bottomed compartment.

Machining of Tungsten Now Possible

A new technique for drilling, grinding, turning, milling, threading and tapping tungsten metal permits the machining of tungsten parts on ordinary metalworking machines. Previously, complicated shapes could not be machined due to the extreme hardness and brittleness of the metal. But with the new technique originated by Philips Laboratories Inc., tungsten parts have been manufactured to tolerances comparable to those achieved with brass or steel.

Model Laboratory "Demagnetized"

Having a permanent installation of modified Helmholtz coils, a new Naval ship-model laboratory can duplicate any magnetic field encountered by an actual ship. The coils compensate for the earth's magnetic field in the area, so that ship models can be studied in an area completely free of magnetic influence if desired. A master console with 357 controls handles equipment operation. Results will be used to explore methods of protecting ships against magnetic mines and torpedoes.

"Puffer" Blows Out Circuit-Breaker Arcs

Providing a short puff of air across the contacts as they separate, an auxiliary "puffer" helps blow out the arc in large circuit breakers built by Westinghouse. The device, consisting of a cylinder and piston, is especially useful in breaking low-current arcs, since magnetic forces developed by a small current are often insufficient to drive the arc into the interrupter. It helps, however, to shorten blowout time to less than the standard eight cycles with all currents from zero to 1000 amperes.

Photoelastic Stress Analysis in Three Dimensions

Actual principal stresses at any interior point of a plastic model of a part or component can be determined by a new three-dimensional photoelastic stress analysis method. Previously, with two-dimensional analysis, only principal shears could be found. With the new method developed at the Illinois Institute of Technology, a plastic model is machined, then placed

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in a special furnace. Loads are applied while the model is heated to the correct temperature, and are not removed until after the model cools to room temperature. The complete stress system is thus fixed or "frozen," and can be studied in detail by slicing or sectioning the model and examining the sections in a photoelastic polariscope.

Stainless-Steel Paint Developed

Flakes of stainless steel, mixed with a suitable vehicle, have been found to be a very desirable finish for resisting certain types of corrosion, according to Westinghouse Electric Corp. Having a gray matte finish, the stainless steel paint can resist attack by alkaline agents, whereas standard aluminum pigments cannot. Although a full evaluation is not yet possible, the new paint appears to be particularly good in industrial atmospheres.

Carbon Absorption in Alloys Prevented

Failure of aircraft exhaust-system parts due to carbon absorption in stainless-steel alloys can be prevented, according to a NACA research report. Heat-resistant alloys were coated with special ceramics, which completely prevented carbon absorption even under strongly carburizing conditions at 1500 to 1650 F.

...IN GOVERNMENT AND INDUSTRY

Machines Beat Flowers as Major Air Cargo

First place as an air-freight commodity went to machines and machine parts in 1951, according to United Air Lines, and cut flowers—the 1950 winner—moved to second place. Third through sixth places went to electrical and electronic equipment, automotive parts, radios and parts, and aircraft parts and accessories.

New Agency to Catalog Technical Information

Technical information generated by or for military departments will be easier to locate in the future, thanks to ASTIA (Armed Services Technical Information Agency). Organized to provide bibliographical services on scientific and technical reports for military agencies, contractors and other authorized agencies, ASTIA will first face the job of collecting, cataloging and storing technical documents, and of integrating the services formerly provided by the Central Air Documents Office and the Naval Research Section of the Library of Congress.

Sugar Sweetens Rubber Production

Production of synthetic rubber can be boosted 26 per cent with a new process involving the use of sugar as an activator, according to W. S. Richardson, president of B. F. Goodrich Chemical Co. The new formula is being used at the world's largest rubber plant at Institute, W. Va., in the production of "hot" rubber made at 122 F—as contrasted with "cold" rubber made at 41 F.

New Gage for Small Business

Recognition of "small" business in various government programs will be aided by a new classification adopted recently by the Department of Commerce. The former classification labeled every firm with under 500 employees as "small," regardless of the the firm's position in its own industry. Generally, in the new classification, the group of businesses producing one-third of the products in each industry is considered the "small" business group, and definite classifications have been released for 452 industries. All firms with under 100 employees, however, are considered "small," and all with over 2500 are automatically "large."

FEBRUARY 1952

MACHINE DESIGN

Challenge for the Future!

A CURIOUS aspect of the increasing mechanization of our civilization is the shift in the distribution of human skills. While certain individuals are developing exceptional skills most people are losing theirs or failing to acquire those of their forebears.

Thus, many people driving automobiles today have never operated a clutch pedal. How would they manage a car of pre-synchromesh vintage on a mountain road? Double-declutching is a lost art.

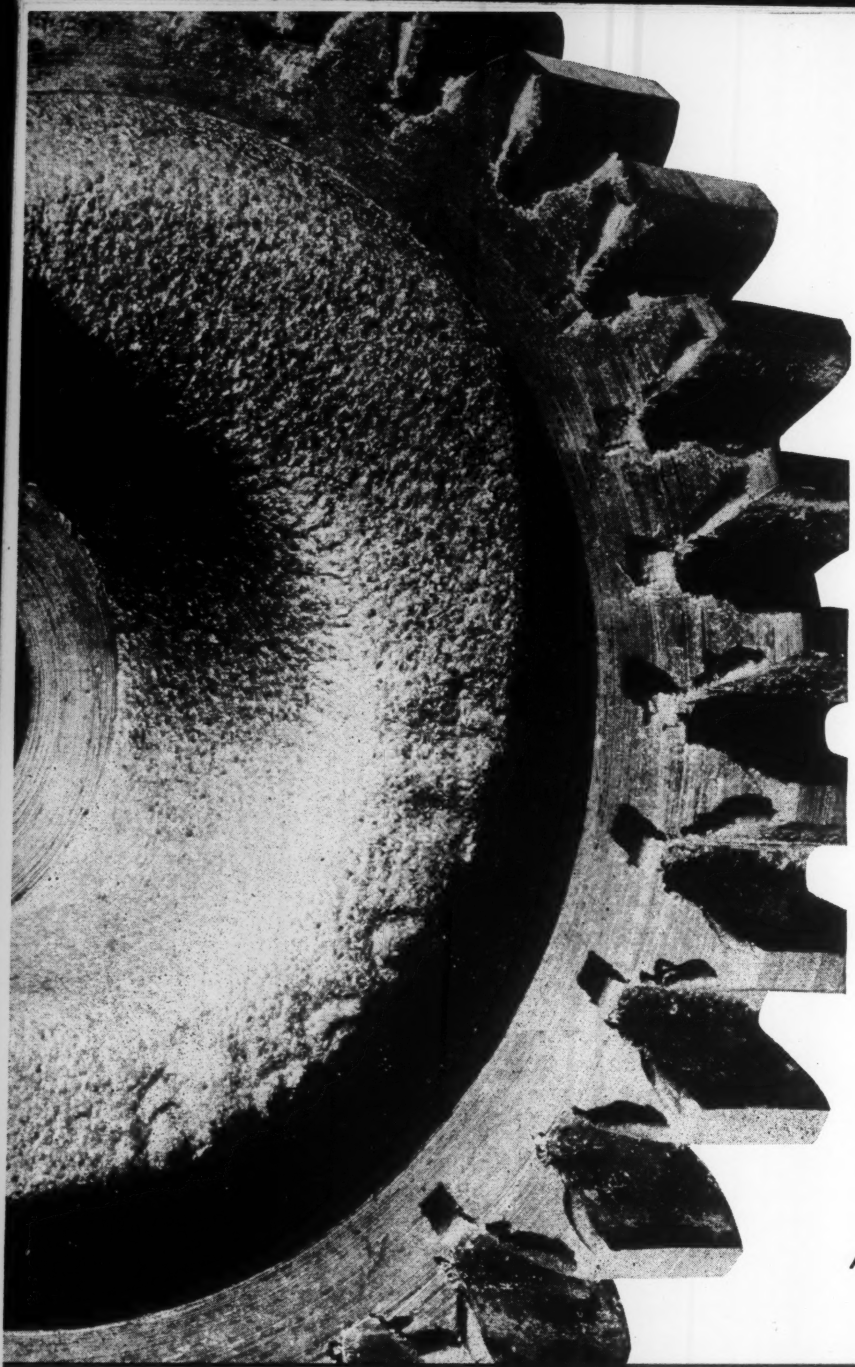
We are told, too, that modern military aircraft are being flown by rote rather than by skill. Speed and complexity make it necessary, while instruments and controls make it possible, to develop operating techniques which depend on well co-ordinated routine rather than on skill of the sort possessed by an earlier generation of pilots who could "fly by the seat of their pants."

Importance of the effect on industry of declining levels of skill is forcibly brought out by a survey recently conducted by the American Society of Tool Engineers in key industrial plants. Fully half of those polled said their greatest need is for machine controls so simple and foolproof that even the most unskilled workers can operate them.

Where does this leave the design engineer? It simply means that in proportion to the decline of skill among machine users the engineer's skill must increase. The designer of today's automatic transmission, aircraft control or machine tool calls upon skills unheard of by his immediate predecessors. It is an exciting prospect, one which opens up new avenues of interest to challenge the abilities of design engineers to the utmost.

Colin Carmichael

EDITOR



Power Brush Finishing

. . . has many attractive possibilities for the designer. This article highlights the important factors in the selection and application of brushes for specific finishes

By V. K. Charvat and R. C. Sasena
Asst. Mgr., Technical Dept. *Special Projects Engin*
Osborn Manufacturing Co.
Cleveland, Ohio

APPLICATION of power driven brushes to obtain necessary, unusual or more refined surface finishes is advancing rapidly owing to increased knowledge of how to select and operate brushes. With the knowledge that brushes, especially roll and wheel type, are capable of many economical surface conditioning operations, it is the purpose here to collect, organize and discuss the pertinent principles and details so that designers can utilize this production method more effectively. Modern power brushing offers machine designers a new tool to help solve many manufacturing problems which they are called upon to overcome.

A brush is a tool that works on a surface or an edge and affects the area brushed in such a way as to smooth or roughen the surfaces, to remove surface encrustations, or to remove burrs. It should be noted that a brush is not a tool which is practical for metal removal to achieve a specific dimension. On the other hand, it is quite possible for a brush to remove burrs from an edge and produce a radius. Where a brush can act on an edge, it is possible to remove the metal required to produce a radius, whereas on flat surfaces it is practical only to produce certain surface characteristics which do not involve the removal of metal. A typical application for a brush is to reduce the surface roughness of a ground part, say from 25 to 35 micro inches rms to 8 to 10 micro inches rms for the purposes of reducing stress concentrations.

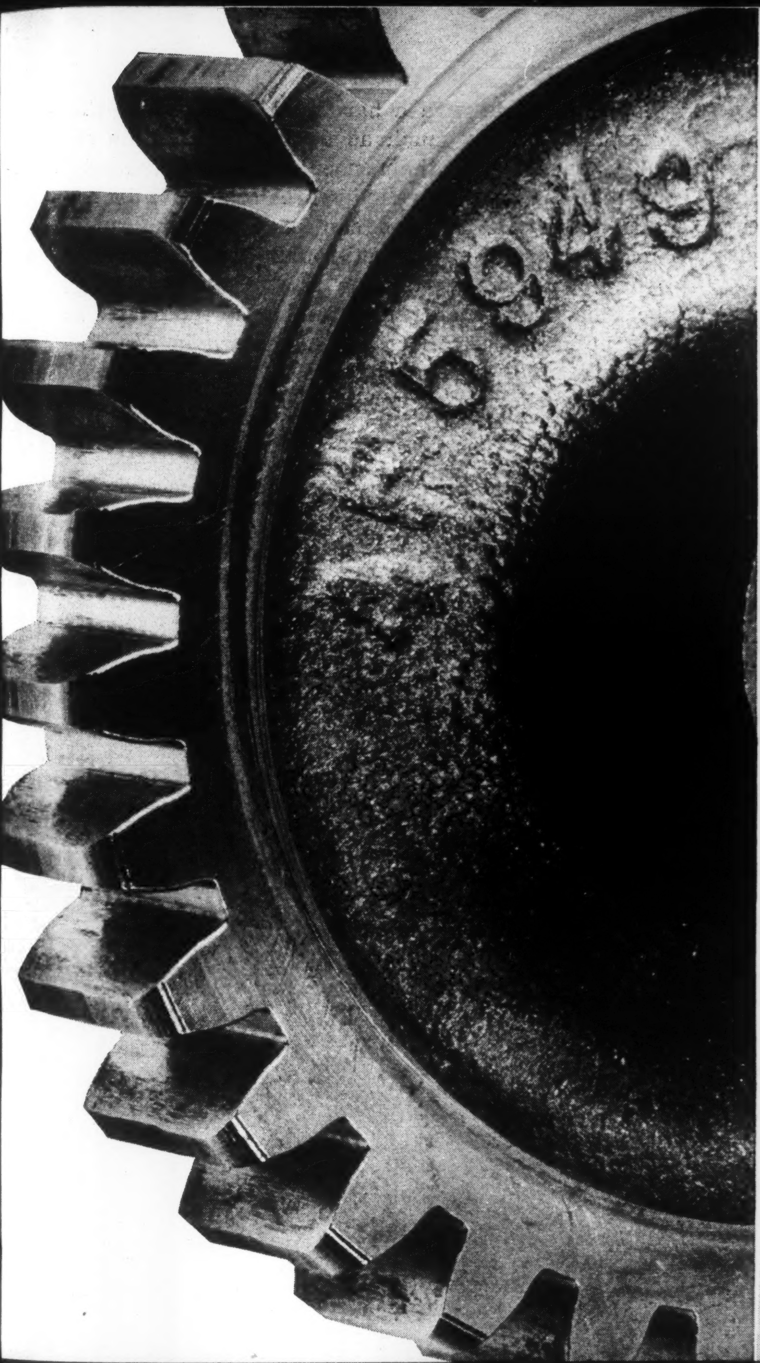
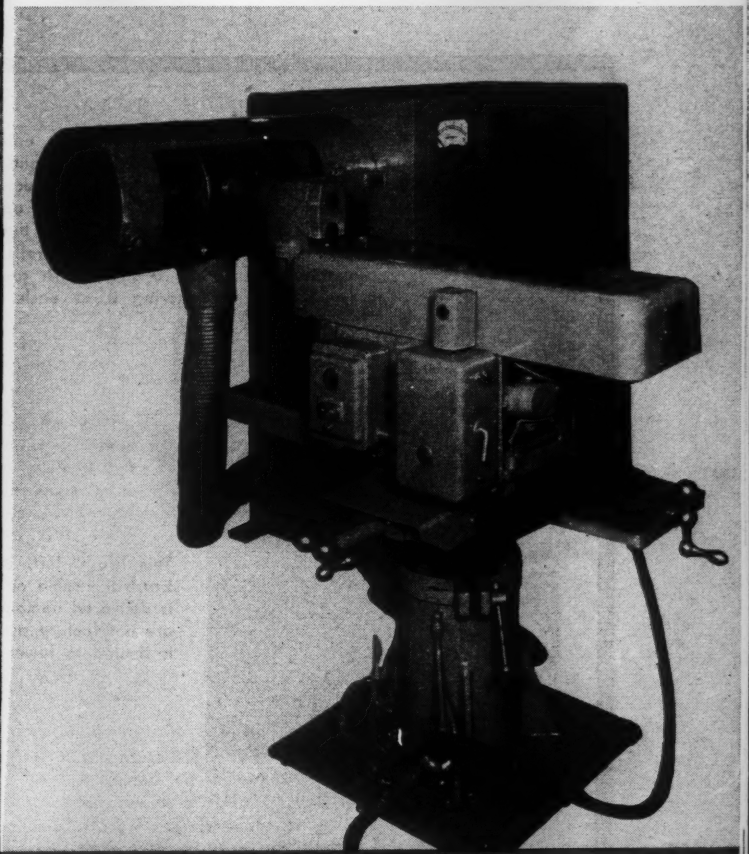


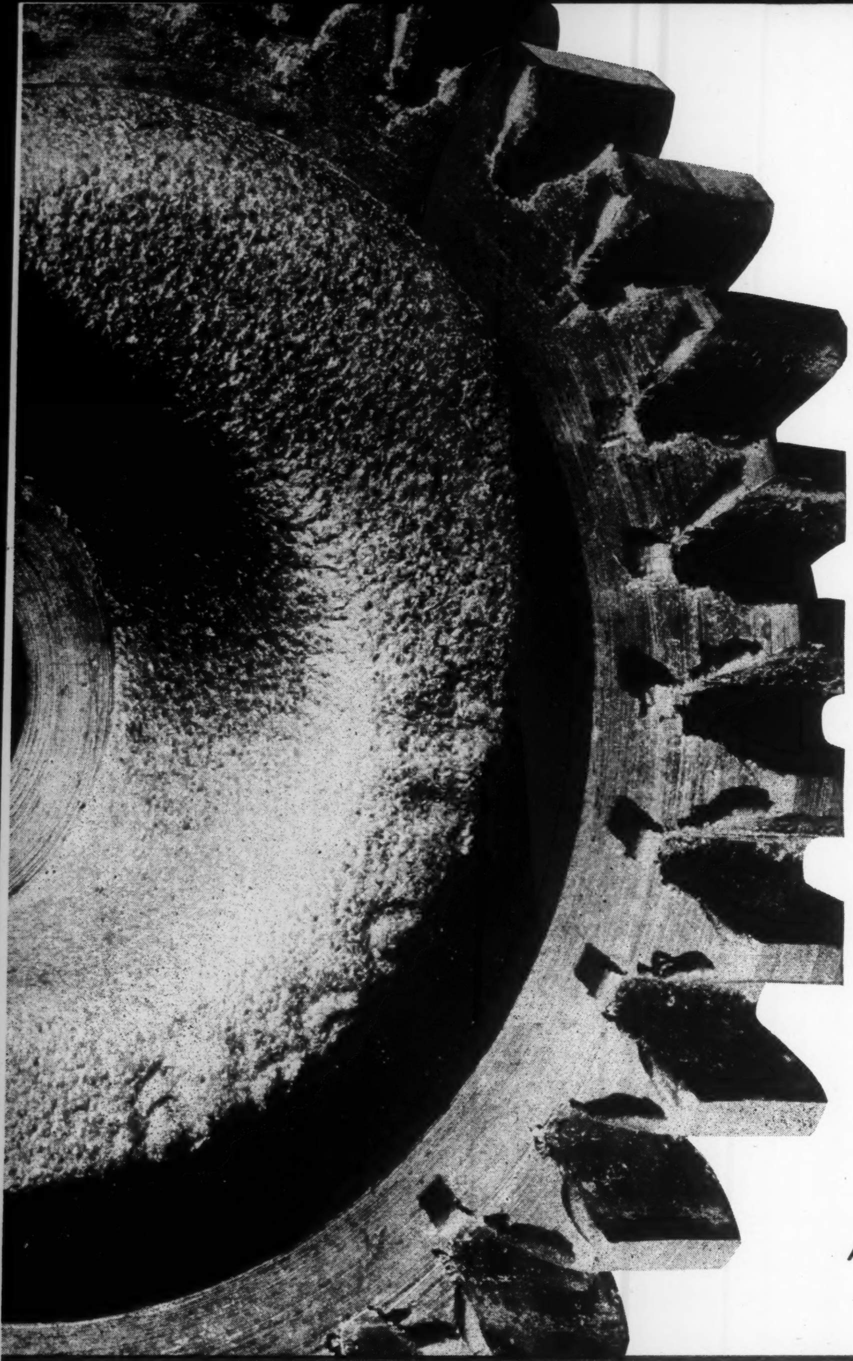
Fig. 1—Left—Gear before brushing to remove burrs and sharp edges, left, and after rapid brushing, right. Each gear is finished in 18 seconds including handling time, compared to 3 minutes with a hand tool and no secondary burr or other sharp edges are created

Fig. 2—Below—With this machine, designed expressly for such work as removing burrs from gears, production increases of as high as 600 per cent have been realized. Operator merely loads and unloads the work; all other operations are pre-set and automatic



Burr Removal: Economical and effective automatic and semiautomatic operations are required to deburr, descale, scrub, finish, or otherwise change surface characteristics or conditions of sheet, strip, rod, cast, formed, or machined articles. With well designed machines capable of handling and guiding work, these operations can be accomplished by brushes at a rate comparable to other related manufacturing operations used. Thus, with thorough consideration of proper application, power brushing methods can constitute a real source of help to machine designers in reducing labor costs by minimizing skilled labor requirements.

A good example of such accomplishment is a new brushing method which is finding unusual success in removing burrs from gears efficiently, while producing results of high quality, *Fig.* 1. For many years emphasis had been placed on the development of gear cutting equipment, with the result that gears can be cut rapidly and with great accuracy. At the same time, relatively little work was done in the development of suitable methods for the removal of burrs. The selection of methods for doing the job of removing burrs, sharp edges, tool marks, and metallic particles was often left to the shop. Consequently, slow laborious methods became accepted standards and much time and labor was lost unintentionally. More important was the fact that the strength of the gear was often impaired. With demand for both increased quality and quantity production, as well as to obtain higher quality at lower cost, brushing meth-



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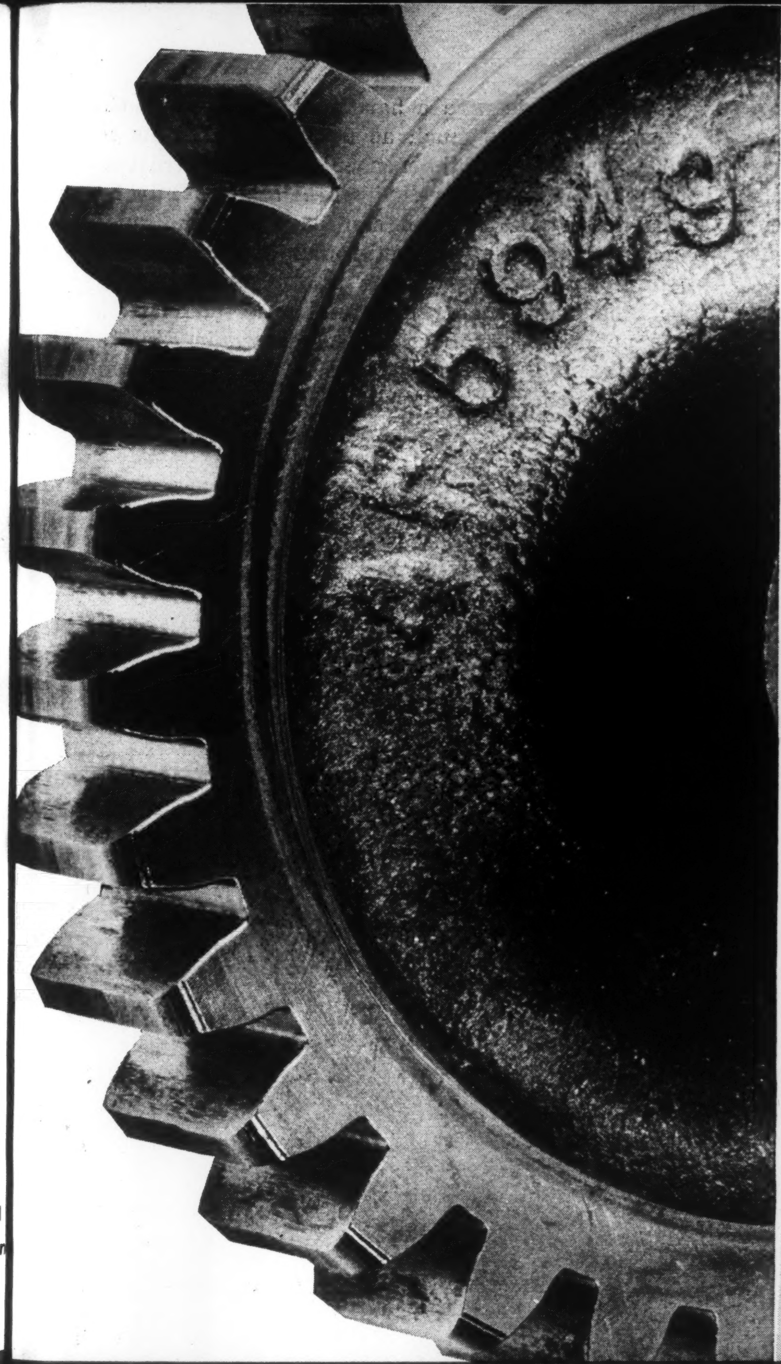

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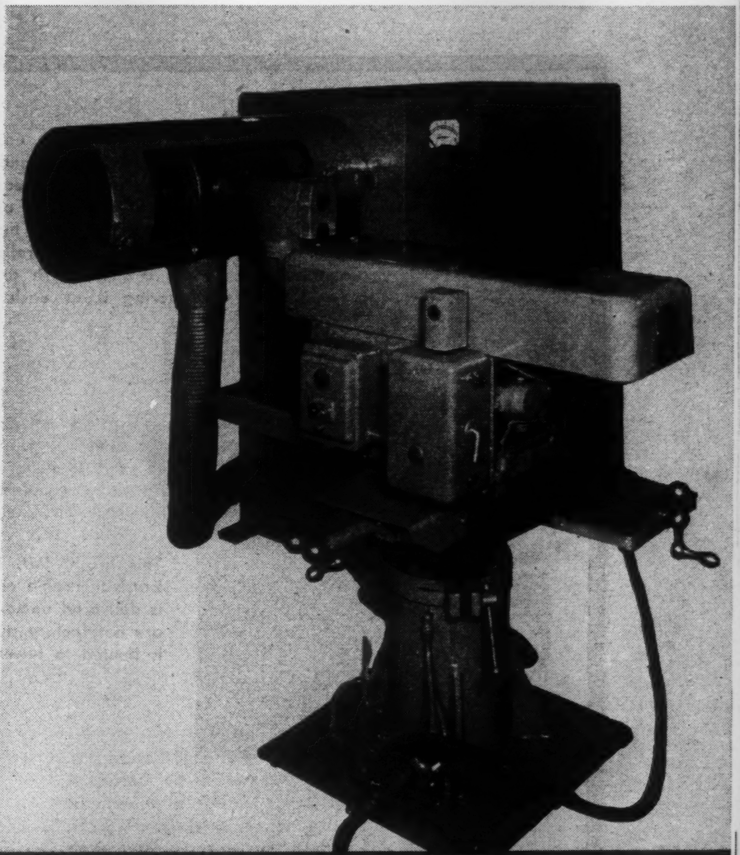

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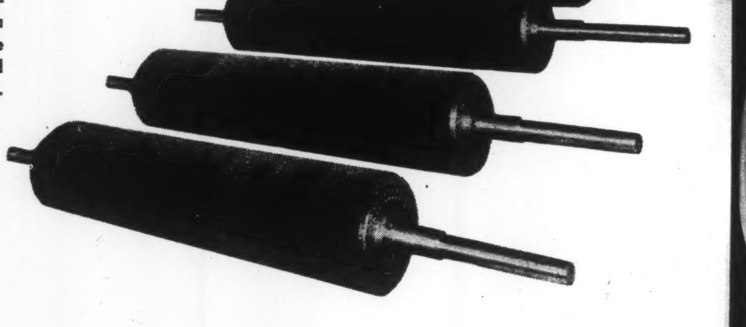
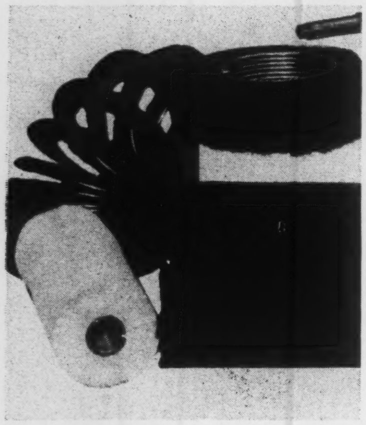
Surface Refinement: Primary cause of as high as 80 per cent of the troubles with certain machine parts is due to stress concentrations and resulting progressive fractures. Fractures occur usually at sharp edges and abrupt changes of cross-section, where the V-notch effect of tool marks, scratches and flaws have presented the opportunity for the stress to exceed the strength of the material.

Some investigators have shown that a sharp corner or edge may reduce the endurance limits of a part as much as 50 per cent. A distinct V notch, such as would be made with a hard tool, may reduce the endurance limit as much as 60 per cent. This reduction, traceable to the concentration of stresses, can be minimized effectively by brushing. While removing the burrs, brushes can produce simultaneously smooth surfaces and well-rounded edges. Tool and grinding marks as well as intersecting surfaces can be blended, reducing the number of potential starting points for small cracks, as shown in *Fig.* 1. Although small cracks may not always cause complete fracture, they often result in small burrs and loose

Fig. 3—Typical power brushes, their characteristics and applications

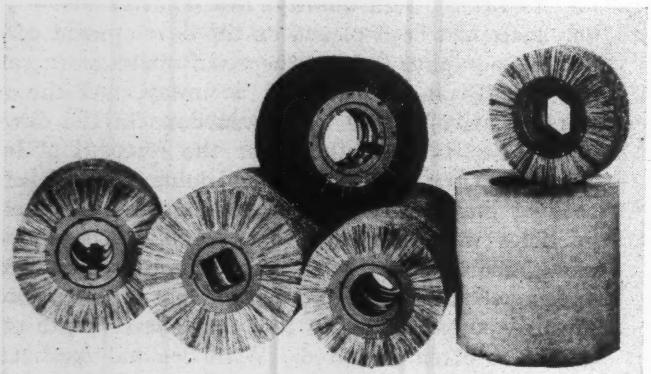
These brush rolls, right, are built to have uniform brushing faces for brushing speeds up to and exceeding a 10,000 fpm. They are used for cleaning, scrubbing, and finishing as well as heavy-duty operations such as rust and scale removal. Built to have a brush face length up to 180 inches, those rolls are factory assembled by winding a strip brush around the arbor and securely anchoring it at each end.



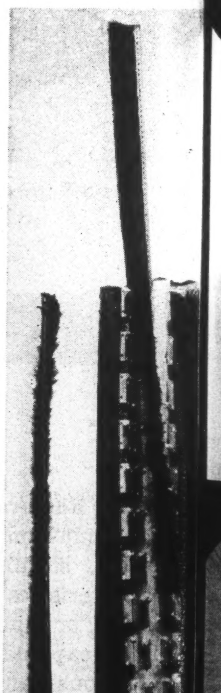


This brush, left, is a closed coil helically wound strip brush the same as used in the high-speed brush roll but is delivered unmounted. However, because these brushes are not factory assembled and balanced, their operation is limited to lower speeds and lighter jobs.

The unit type brushing roll, below, is a hard working brush of welded one-piece construction designed for fast, easy removal and mounting direct on square, round with key, or hex arbors. These brushes are generally made in face widths of 5 to 35 inches. For long brush face lengths, several unit type brushes are mounted in tandem on the arbor.



Strip brush rolls, right, are especially suited for wide face applications requiring brushes of relatively low density or contoured faces. This type is probably one of the most versatile of all brushes in that the density can be varied from as few as 2 strips to 18 or more. Further, the brushing face can be made to various shapes such as concave and convex by designing the mounting appropriately. Strips can be removed and replaced as needed.



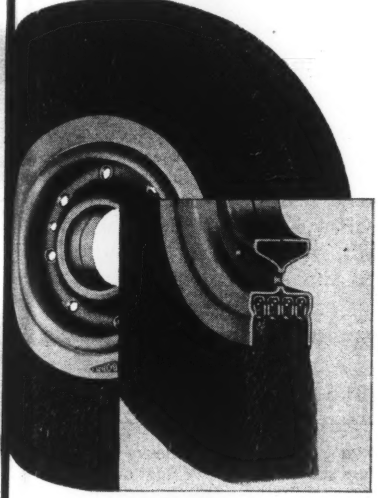
metal particles that will foul lubrication systems and cause unnecessary wear.

Selection of Brushes: Each application of power brushing, whether it be removal of burrs, sharp corners, tool marks, or improvement of surface finish must be engineered. Each job has its own characteristics, and each must be studied. Selection of a power brush for a given application is done best after compiling information along the following lines:

1. What is to be accomplished?
    - a. Clean or remove—what material?
    - b. Roughen or smooth—what kind of surface?
    - c. Finish or polish—to what degree?
    - d. Round corners or blend surfaces—how much?
2. What kind of equipment is available?
    - a. Brushing lathe—what horsepower and speed?
    - b. Automatic brushing machine—what type?
    - c. Portable—hand or flexible shaft equipment?
3. What are the properties of the material involved, especially hardness?
4. At what rate and under what conditions must the work be done?

Answers to these basic questions will usually furnish the facts necessary to determine brush type and material and brushing technique required.

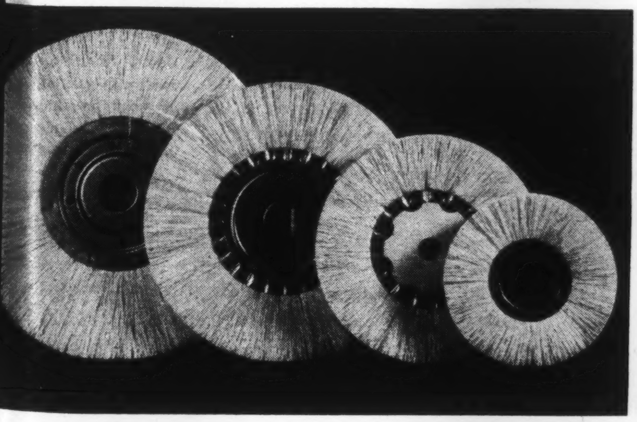
Brushing wheels can produce a wide variety of finishes depending on the wheel material, and how the wheel is applied. *Fig.* 3 shows some of the roll



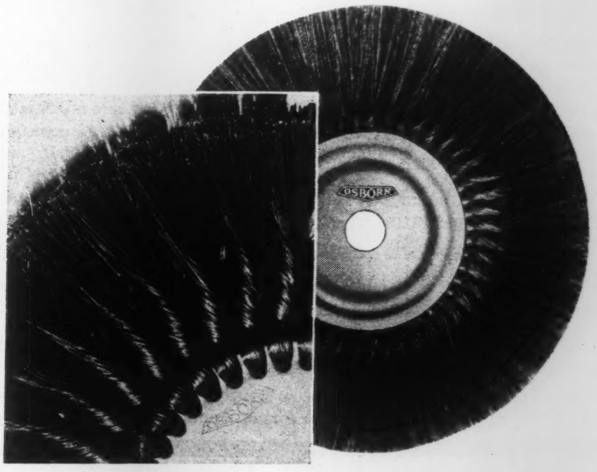
Typical wide-face wire wheel brushes, left, are characterized by a high fill density. Close wire tip packing, most easily developed in wide-face brushes, is complemented by relatively short wire length. This combination produces a strong file-like brushing action of relatively low flexibility or cushion especially well suited to such work as removing burrs.

A narrow-face wire wheel brush, right, serves for brushing areas where clearance is a factor or where the shape is not relatively flat. Construction of this brush limits the density which with a longer trim provides characteristics midway between wide-face wire wheels and coil-knot wire brushes. This brush can be made into a wide-face brush of multiple sections although this modifies its performance in the direction of the wide-face wire brush wheel.

This nonmetallic treated Tampico section brush, below, is most frequently used in a wheel made up of more than two or three sections. Such a built-up wheel is used with abrasive compounds for operations such as removing burrs and producing radii on machined parts. By special treatment the brush is made stiffer and more compact than plain untreated Tampico brushes. The treatment controls the fibers in a way to make them hold abrasive compounds better and to make the brush wear longer. Untreated Tampico brushes are used for dry and wet cleaning principally, although they are sometimes used with abrasives where a mild brushing action is required.



This narrow-face coil-knot wire wheel brush, below, is constructed to permit high-speed operation and to provide a strong impact type brushing action which is excellent for removing surface encrustations such as scale and rust. This brush is by virtue of its construction very flexible.



For Jobs Requiring Surface Finish Less Than 30 Microinches rms			For Jobs Which Permit or Require Surface Finish Exceeding 30 Microinches rms*		
Brush Flexibility			Brush Flexibility		
Medium		High	Low		High
Brush Finishing Ability			Brush Finishing Ability		
Very Fine (Low rms)		Medium	Fine		Coarse
Brushing Action			Brushing Action		
Medium		Very Fast	Medium Fast	Medium	Fast
Cord & Fabric Brushes	Tampico & Treated Tampico Brushes	Fine Wire Sections Used With Burring Compound	Wire Wheels	Wire Sections	Coiled Knot Sections
Major Brush Characteristics					
Fast cutting medium flexible wheels. Used with cut and color buffing compounds for producing low microinch finishes	Flexible, fast cutting wheels. Used with burring compounds of tacky composition for producing surface finishes of approx. 8 to 10 microinches rms	For efficient use of wire brushes with compound, select brushes having medium or high density and fine wire size (0.008 diam or finer)	Wide face, dense fill. Used where fast cutting and fine finishes are required. Best general purpose wire brush	Narrow face, medium density. Used where medium brush flexibility is essential to follow contoured surfaces	Narrow face, low density. Used where a high degree of brush flexibility is needed and where surface impact action is necessary, especially to remove surface encrustations
Major Applications in Order of General Usage					
1. Cut and color buffing 2. Surface blending 3. Light scale removal 4. Producing radii 5. Burr removal	1 Burr (small) removal 2. Producing radii 3. Light scale removal 4. Surface blending 5. Cleaning 6. Satin finishing	1. Burr (medium) removal 2. Light scale removal 3. Satin finishing 4. Producing radii	1 Burr (heavy) removal 2. Producing radii 3. Rust and oxide removal 4. Scale removal 5. Cleaning 6. Surface blending	1. Cleaning 2. Medium scale removal 3. Rust and oxide removal 4. Satin finishing 5. Surface blending 6. Burr removal	1. Heavy scale removal 2. Rust and oxide removal 3. Satin finishing 4. Producing radii 5. Burr removal (on very hard metals)
Adjustments For Desired Results					
Brush works too slowly	Brush works too fast	Action of brush peens burr to adjacent surface	Finer or smoother finish required	Finish too smooth and lustrous	Brushing action not sufficiently uniform
1. Increase surface speed by increasing OD or rpm 2. Decrease trim length and increase fill density 3. Increase filament diam	1. Reduce surface speed by reducing rpm or OD 2. Reduce filament diam 3. Reduce fill density 4. Increase trim length	1. Decrease trim length and increase fill density 2. If wire brush tests indicate metal too ductile (burr is peened rather than removed), change to nonmetallic brush such as a treated Tampico used with burring compound	1. Decrease trim length and increase fill density 2. Decrease wire diam 3. Try treated Tampico or cord brushes with suitable compounds at recommended speeds 4. Use auxiliary buffing compound with brush	1. Increase trim length 2. Reduce brush fill density 3. Reduce surface speed 4. Increase filament diam	1. Increase trim length and decrease fill density 2. Devise hand held or mechanical fixture or machine which will avoid irregular off-hand manipulation

*For very ductile metals see Adjustments Column 3

Fig. 4—Chart for rational selection and specification of brush requirements

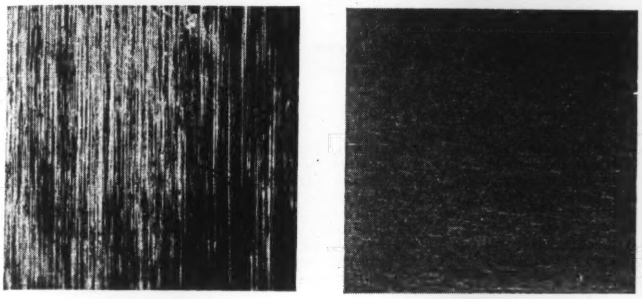


Fig. 5—Above—These photomicrographs show the reduction of surface imperfections which are obtainable through brushing. Comparison of the two surfaces emphasizes the improvements in surface appearance produced by brushing a cold-rolled steel surface 120-grit wheel dry polished with a Tampico brush and 120-grit aluminum oxide compound

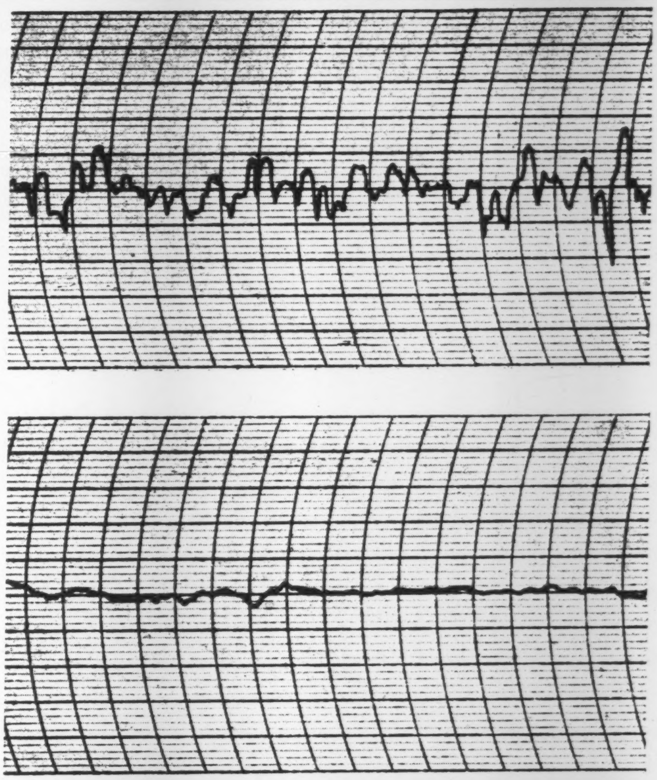


Fig. 6—Right—Top chart shows microinch roughness of a surface that has been finished using a polishing wheel with 120 grain size. The lower chart shows roughness of the same surface after brushing operation

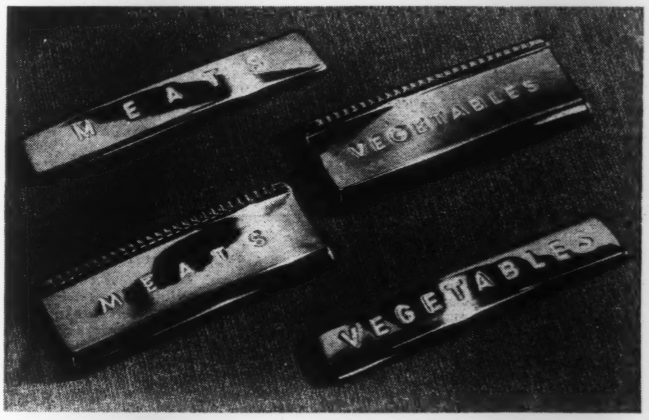


Fig. 7—Below—Stainless steel parts mass-finished with brushes in one pass using three brushing heads. Particular attention is called to the sharpness of the letters which has not been destroyed

and wheel type brushes and gives some applications. For practical selection, brushes may be classified as follows:

Cord or Fabric Brushes: Fast cutting medium-flexible wheels used with cut and color compounds for producing low microinch finishes

Tampico and Treated Tampico Brushes: Flexible, fast cutting wheels used with burring compounds of tacky composition for producing surface finishes of approximately 8 to 10 microinches rms

Fine Wire Sections Used with Burring Compound: For efficient use of wire brushes with compound, select wire brushes having medium or high density and fine wire size (0.008-inch diameter wire or finer)

Wire Wheels: Wide face, dense fill, used where fast cutting and fine finishes are required. Best general-purpose wire brush

Wire Sections: Narrow-face, medium-density, used where medium brush flexibility is essential to follow contoured surfaces

Coiled Knot Sections: Narrow-face, low-density wire brush used where high brush flexibility is needed and where surface impact action is necessary, especially to remove surface encrustations.

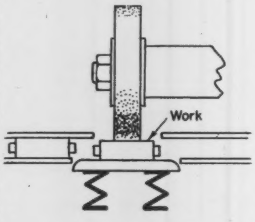
The comprehensive chart in *Fig.* 4 provides a good basis for brush selection. This chart takes into consideration jobs requiring surface finish less than 30 microinches, rms and jobs which permit or require surface finish exceeding 30 microinches rms.

Surface Finishes Produced by Brushes: Tampico and cord brushes can modify and change the condition of metallic surfaces very appreciably. It is this ability which gives these brushes value for polishing and buffing. The action of a brush is that of blending imperfections and surface irregularities rather than the actual removal of metal as is obtained with abrasive wheels or belts. It has also been demonstrated that the blending action of a brush reduces surface imperfections to a state where a uniformly good plating job can be obtained. This can be done without the need for cutting an entire surface down to the depth of the deepest surface imperfections and therefore fewer wheels or passes are required.

The results shown in the photomicrographs of *Fig.* 5 characterize the reduction in surface imperfections which are obtainable through the use of brushing. Comparison of the two surfaces shown emphasizes the improvements in surface appearance produced by brushing. However, it is of equal importance that these surfaces be evaluated by examining the charts in *Fig.* 6 which show the surface roughness in microinches and the magnitude of the sharpness of the surface marks as measured by a Brush Surface Analyzer.

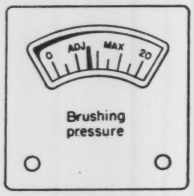
Sharp edges or groove-like marks which are pro-

Design Factors for Bru



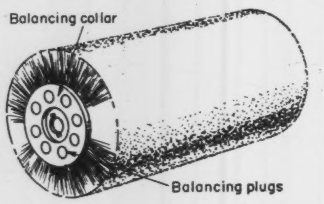
Brushing Pressure Relief

Good production brushing requires that provision be made to allow pressure relief under conditions of extreme brushing pressure caused by misalignment, oversize or improper seating of the part. This feature is especially necessary for brushes having a short trim or a dense fill where the brushing face could be damaged because of the inability of the individual filaments to escape being stressed beyond the yield point. There are two ways of accomplishing pressure relief. For small parts it is usually best to allow the part to retract, especially where this can be done so as to allow a straight pass line to be maintained. The second method, which is standard practice for polishing and buffing work, is to have the brushing head floating so as to allow the brush to fall and rise as the contour may require during the operation.



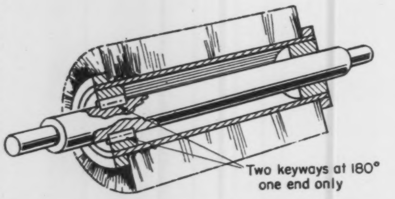
Brushing Pressure Meter

Brushing pressure affects the quality of the work and the life of the brush to a very considerable extent. It is essential to have brushing pressure meters on all brushing machinery since it is not possible to visually estimate brushing pressure. An ammeter connected to the driving motor circuit for each brushing head is recommended for this purpose as a permanent part of the machine. Ammeters have been successfully used for this work and can be quickly calibrated to suit each individual job so as to eliminate guess work. Quantitative knowledge of brushing pressure during the entire period of operation of the machine is most essential.



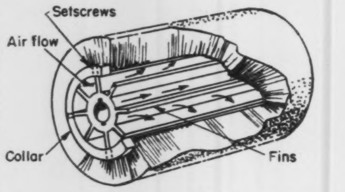
Brush Balance

Satisfactory machine operation usually requires the use of balanced brushes. This is especially true for long brushing rolls and for wheels or rolls which operate at speeds in excess of 100 rpm. Best practice requires that the shaft, mounting and the brush be dynamically balanced to within one-half ounce-inch.



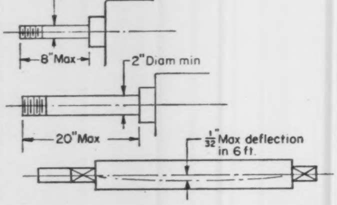
Keyways

Keyways should be specified and used for long-face brushes, heavy-duty work and where the brush reversal method of face conditioning is used. American Standard keyways are recommended. On long-face brushes which are adapted to a shaft with a mounting it is recommended that two keyways 180 degrees apart, one end only, be used. Keyways on both ends of the brush mounting produce alignment difficulties.



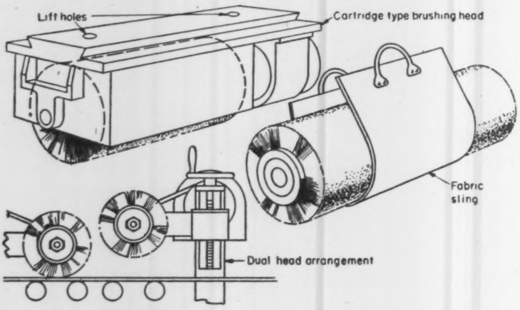
Brush Ventilation

Brush ventilation is extremely important where brushing rolls or wheels are used under conditions of continuous and/or heavy duty and where the brushing roll face exceeds the length of four to six inches. Radial fin type mountings with ends open to allow free passage of air as shown are good for obtaining the required ventilation. When using such a mounting it is very important to provide adequate room at each end of the brush so that sheave and bearing housings do not block the openings in the mounting ends. Good practice requires that ventilation be provided also for wheel and sectional brushes of nonmetallic fill materials. Machine flanges must be built with the necessary ventilation openings.


$1\frac{1}{4}''$ Diam min
8" Max
2" Diam min
20" Max
$\frac{1}{32}''$ Max deflection in 6 ft.

Shaft Size

While shaft size standards for brushing machines have been developed as a result of many years of usage it is still essential to calculate the shaft diameter for special machines and operating conditions. In general, for semiautomatic machines having a shaft size length requirement of 8 to 12 inches overhang, a 1¼-inch diameter has been found to be very satisfactory. For this same type of service where the shaft length goes up to a maximum of 20 inches, a 2-inch diameter shaft has been found satisfactory. For a special machine the shaft size is determined on the basis of a uniformly applied load with the shaft fixed at both ends. For brushing operations a maximum deflection of 1/32-inch in six feet is the standard recommended allowance. Shaft size is determined on the basis of standard formulas.

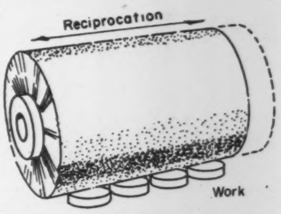


Brush Replacement

Replacement of worn-out brushes is a very important detail for which provision must be made when the brushing machine is designed. The important thing is to make replacement easy and quickly so as to keep machine downtime at the lowest level possible. In fact it is desirable in many cases to design the equipment so as to permit replacing the brushes while the operation continues. For this purpose a spare head is sometimes used so that as a brush becomes worn the spare head can be placed in service while the regular head is being serviced. This must all be done without damaging the face of the brushing roll. An example of what can be done to facilitate brush replacement is illustrated in these sketches.

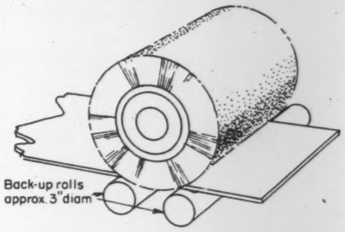
s and Brushing Machines

Brush Roll Reciprocation



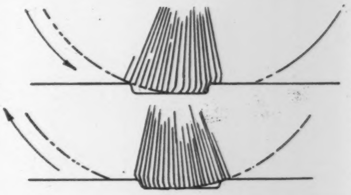
Axial brush roll reciprocation is an excellent means of preventing streaking on such shapes as sheet, strip, and rod. Also, without axial reciprocation the brushing face may become grooved on straight-line work. Best results have been found when the roll is reciprocated one-half to two reciprocations per minute. When brushing parts in multiple the amount of reciprocation must exceed the width or diameter of one part, plus one half of the space between parts.

Back-Up Roll



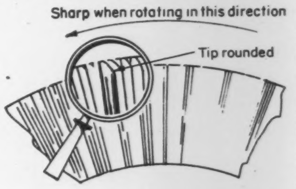
Back-up rolls must be designed to support the part being brushed and yet avoid interference with the brushing roll. A brush roll cannot successsfully serve as a back-up roll for another brush roll. For thin pieces ¼ inch thick and less, two back-up rolls, one on each side of the brush, as shown in the sketch are recommended. For parts which are thicker than ¼ inch, the back-up roll may be immmediately opposite the brush so long as provision is made to prevent contact.

Number of Brushing Heads



Continuous operations for brushing strip, rod and similar materials require the use of brushing heads in multiples of two. This requirement exists because of surface discontinuities and defects which frequently have a shape that will tend to mask the brushing action out of certain areas as indicated in this sketch. By having two brushing heads operating in reverse directions, it can be easily visualized how a more uniform surface finish can be obtained. For brushing to remove surface encrustations such as scale it is most important that this two-direction approach with brushes be followed if pits, fissures and other surface imperfections are to be thoroughly cleaned.

Wire Brush Face Conditioning

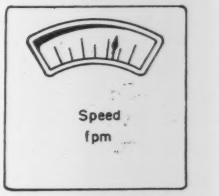


Brushes like other perishable tools must have their working face reconditioned and resharpened. It can be visualized easily how the tip of a brush fill-wire could eventually become dull and lose its working clearance. This clearance must be restored at intervals which are determined by the requirements of the job. Reconditioning and resharpening a brush is accomplished simply and efficiently by alternately reversing the direction of rotation during production.

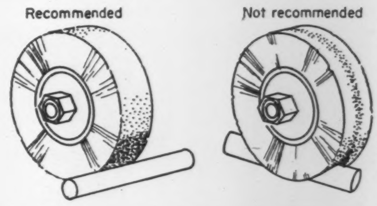
Brushing Speeds

Brushing speeds vary considerably from job to job depending upon the speed of the work or brushing intervals and such other factors as the amount of material to be removed. While it is difficult to give specific speeds, ranges for various general classifications of work are given right in fpm:

Removing burrs	*5500 to 7500*
Blending for mechanical strength	*4700 to 7500*
Cleaning dry (wire brushes)	*4000 to 5500*
Scrubbing wet	*1900 to 4000*
Finishing for appearance:	
Polishing	*6400 to 8000*
Buffing	*8000 to 10,000*
Removing scale	*7500 to 10,000*
Cleaning welds	*7200 to 9400*

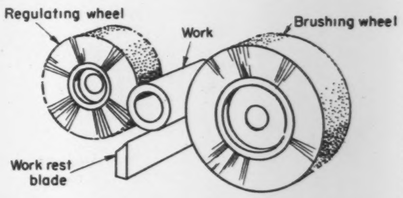


Brush Face Contact



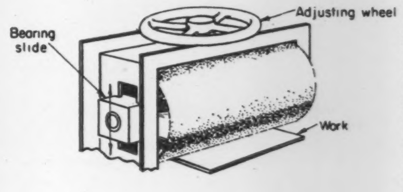
In setting up a brushing operation it is important to have the brushes contact the part being brushed in a way that the full face of the brush is in contact with the part. Except when a reciprocating brush is employed, full brushing face contact is necessary to avoid grooving the brush. Operations which are set up so that the brush face is not in full contact with the work required some provision for dressing the brush face.

Centerless Brushing



This sketch shows schematically a centerless brushing set-up. Brushes, like grinding wheels, can efficiently do work on the centerless principle. Brushes will not reduce parts to a specific dimension but only change the surface characteristics. Brushes are made interchangeable with grinding wheels so that conversion from centerless grinding to centerless brushing merely requires a change of wheel. In most cases the regulating wheel used is the same as for grinding operations.

Wheel or Roll Adjustments



Probably the most important feature of any machine concerns the adjustment of the wheel or roll to obtain the required brushing pressure and to compensate for brush wear. The best results have been obtained when the adjustment of a brush or roll is made through one adjusting screw with micrometer control. The adjusting may be done with a hand wheel or through a gearhead motor operated by pushbutton control. Experience proves it best to avoid independent adjustment.

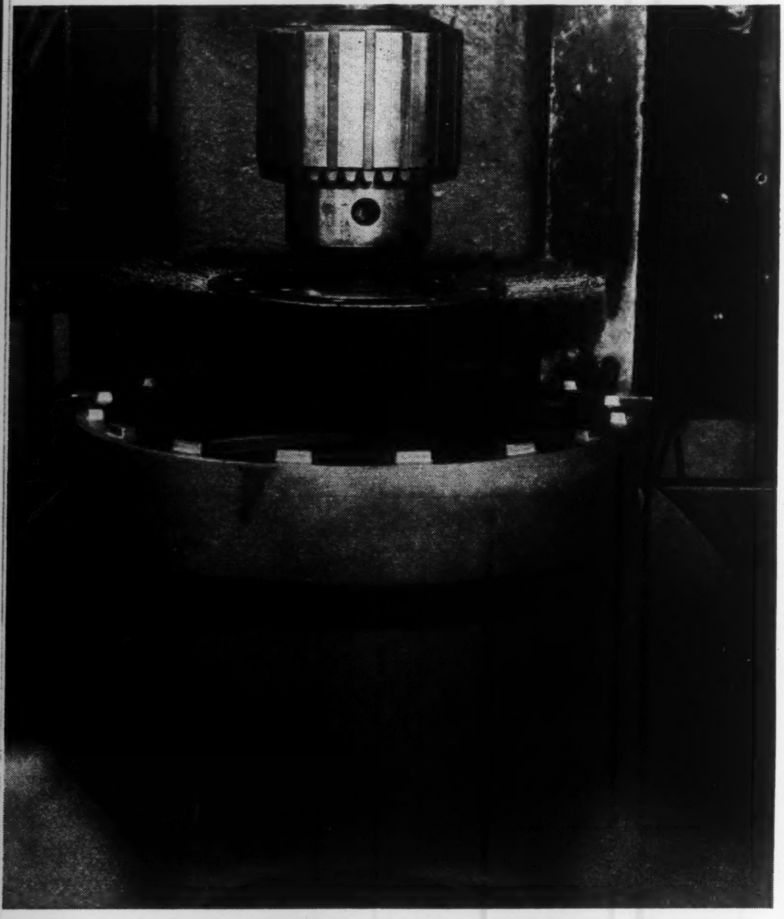


Fig. 8—Above—Used in lieu of honing, an automatic brushing operation on a shot-peened bearing surface of this propeller hub refines the finish

duced by fixed grit wheels or belts tend to build up relatively high current densities at these sharp points and as a result the plating tends to emphasize the surface irregularities. In the case of the sample which has been brushed with a treated Tampico wheel, the surface has been uniformly blended and all sharpness which usually results from fixed grit polishing wheels or belts has been removed. The surface is such that uniform plating should result. The analyzer charts show a surface roughness of 24 to 35 microinches, rms, for the original sample, whereas the same surface brushed with a treated Tampico brush results in a reading of from 4½ to 7 microinches, rms.

Evaluation of a surface brushed preparatory to plating should be made in the light of the results obtained after plating. When comparing a brushed surface with a surface obtained by older methods of polishing and buffing, it will be found that brushes tend to produce a somewhat duller surface finish in which the defects are not hidden. Brushes produce an effect on the surface which is not confined to the high spots but actually refines the entire surface. The result is that the brushed surface plates better by virtue of the greater refinement. It might be noted that an inspection of a brushed surface is less deceptive. After brushing has produced a satisfactory finish, cloth buffs frequently have a place in producing a higher color.

In *Fig.* 7 is shown a group of stainless steel parts efficiently mass-finished with brushes in one pass using three brushing heads. Particular attention is called to the sharpness of the letters which is the result of fast cutting action and firm cushion of the brush.

Brushing Applications: Brushing operations cover

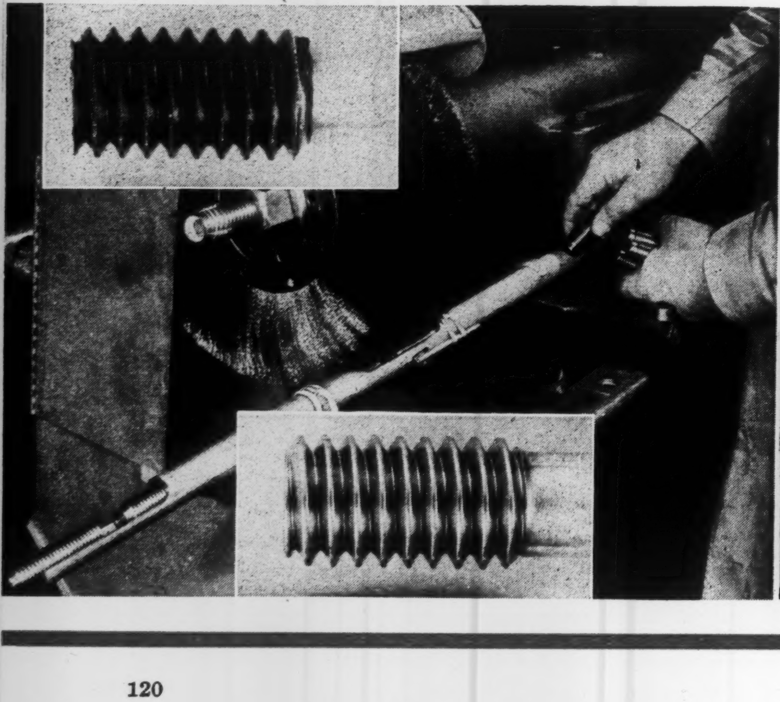


Fig. 9—Below—Photograph of a 5/16-inch steel stud before and after brushing to remove burrs and sharp edges. Brushing not only reduces the possibility of fatigue failures but also aids assembly operations by removing burrs and other waste material

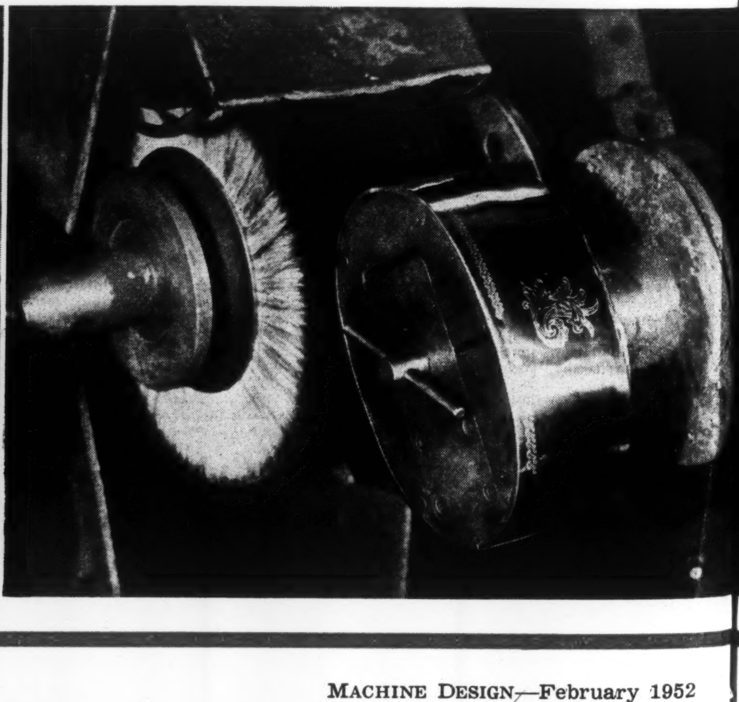


Fig. 10—Curved surface of this toaster shell is finished to high luster with a Tampico brush. Fine details are unblurred by the operation as can be seen

a range of work which utilizes hand held fixtures to fully automatic equipment. The selection of brushing equipment within this range will depend upon the specific job conditions such as production rate, work volume and the work quality desired. On many jobs suitable brushing results can be obtained only if work holding fixtures are designed. For efficient operation, such fixtures should be given as much consideration as any other production jig or fixture. It should be emphasized while in some cases the hand method of applying the parts to the brush may be used, experience has shown that hand held or table attached fixtures can be of considerable aid in increasing production as well as in achieving product uniformity. Accuracy makes it obvious that any hand held method of brushing would be uneconomical. Where the quantity of work would not justify a large automatic machine it is possible to adapt a conventional polishing lathe with relatively inexpensive attachments.

Special Finishing Possible

Finishing of interior surfaces can be made practical, fast and efficient by brushing methods. Often brushes, mounted in holders designed for each job, are good for finishing concentric interior surfaces, with rather simple equipment, *Fig.* 8.

An important feature of a brush is the flexibility or cushion which it embodies and which makes it possible to brush such surfaces as threads on steel studs, *Fig.* 9. As can be seen from these before and after views, the burrs have been removed along with all fragmented metal. The threads are clean and ready for trouble-free assembly.

While high-speed brushes are capable of producing satin and polished finishes on flat parts, their use is particularly advantageous for surfaces not flat where the flexibility inherent in brushes is most fully demonstrated. Ornamental satin finishes readily obtainable with brushes have great utility value because, unlike high-polish finishes which tend to exaggerate minor surface defects, a brush surface finish usually screens such blemishes effectively, *Fig.* 10.

The work of roughing metallic and nonmetallic surfaces to increase the effectiveness of adhesives is quickly done with brushes using either off-hand or automatic methods. Pictured in *Fig.* 11 is a relatively simple machine designed to brush a rubber part. This equipment roughens parts as fast as they can be loaded into the fixtures by the operator. Brush cleaning prior to soldering is also widely employed.

The various brushing jobs described represent a small cross section of the jobs which can be done with brushes. In most cases brushing wheels or rolls are used in their conventional form, while strip brushes and other brush inserts, the mountings are special and are designed to cope with such conditions as limited clearance. In the mechanization of brushes for use on mass production operations, specialized or single-purpose machines are often imperative. Equipment such as the rotary table type or in-line machine is usually a requirement for obtaining the real economies possible, *Fig.* 12.

Brushes and brushing equipment constitute important production tools because they fit particularly into those manufacturing operations where the ratio of labor costs to other production costs is very high and where least development effort has been placed in the past. Many of the operations which can be done with brushes offer the designer the highest rewards in cost savings and improved quality.

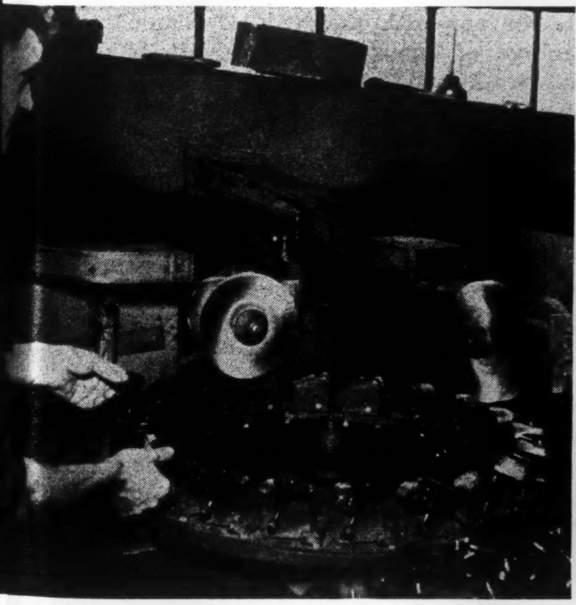


Fig. 11—Roughing of metallic and nonmetallic surfaces to increase effectiveness of adhesives is quickly done with brushes using either off-hand or automatic methods. All guards on this machine have been removed to show the brushes in operation

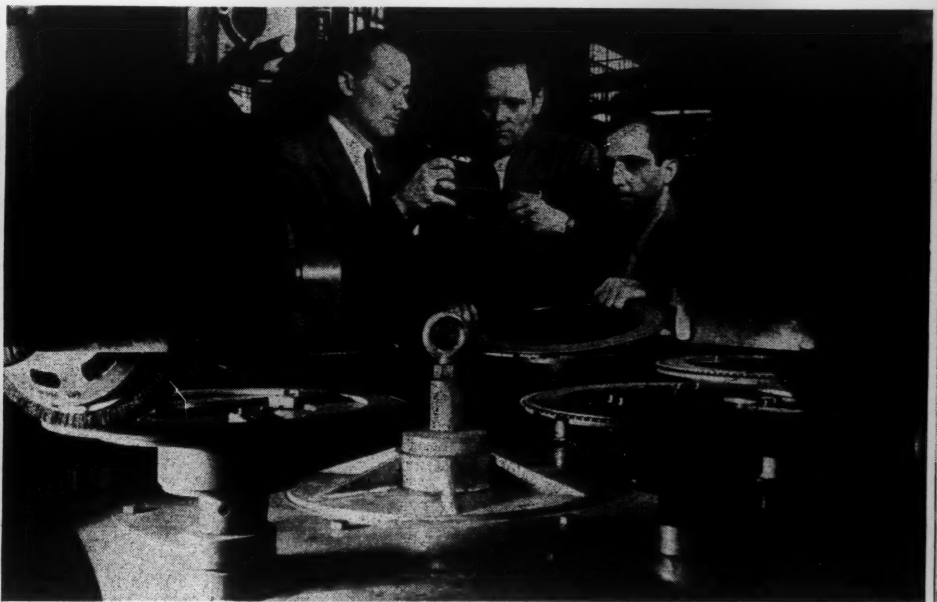
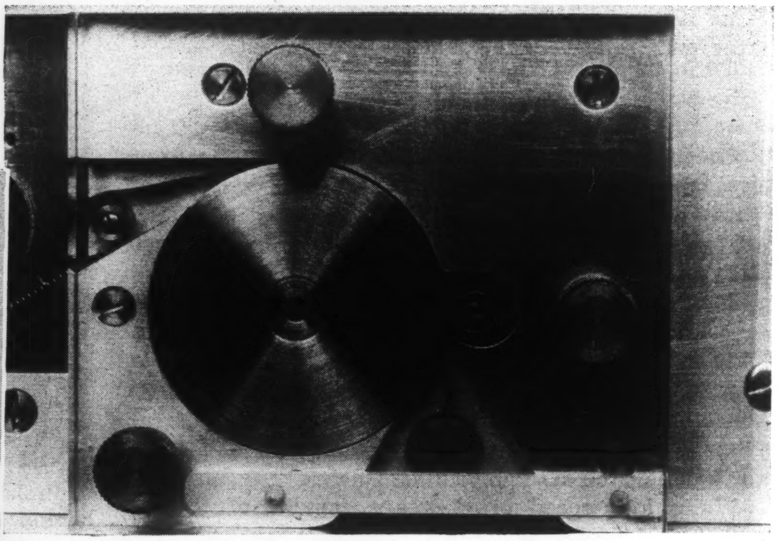
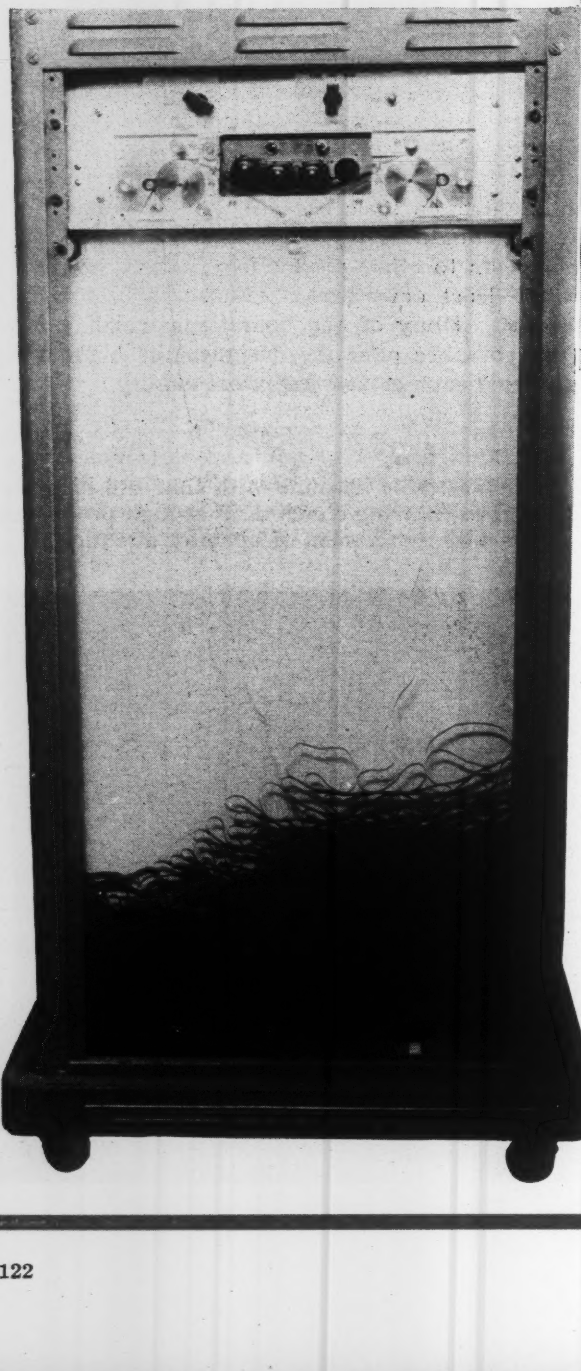


Fig. 12—Rotary table machine with four brushing stations used for deburring clutch disks at high production speeds with a minimum of operator attention

SCANNING the Field For Ideas

Memory unit, below, stores data obtained from a computer for reuse in calculations as required. Since electronic digital computers have limited storage capacity in their internal high-speed memory where partial solutions are stored until needed later in the course of solution of a problem, this memory unit facilitates feeding stored data back into computer as needed.





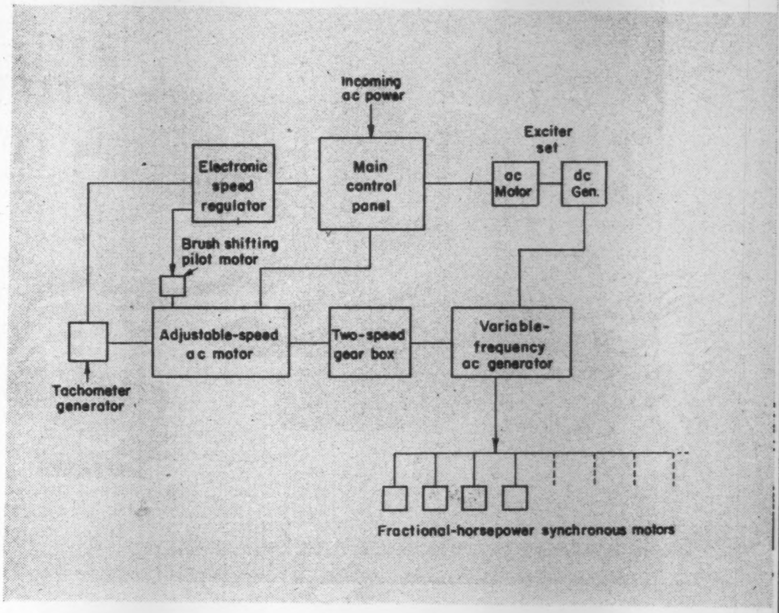
Previous methods of storing data have been complex, expensive and relatively slow involving as much as 95 per cent of the computing time to feed back data. This memory, developed at the National Bureau of Standards for use with their SEAC computer, has the advantage of combining speed with simplicity and economy. These features are achieved through the elimination of reels and servomechanisms. Only two small masses are accelerated in starting the tape, a small jam roller and a few feet of tape.

The jam roller, a rubber-covered ball bearing shown at the right in the closeup view, above, is operated by a solenoid to press the tape against the larger smooth-surface roller for starting and stopping the tape. Instant reversal is obtained by operation of the jam roller on the second wheel. Both drive wheels operate continuously in opposite directions.

Although the compartments are large enough to hold several thousand feet of tape, an ordinary 1200-foot length is ample for most problems. Three sheets of glass are separated to make two compartments which clear the tape sufficiently so that the loose folds in which the tape falls have no tendency to turn over or become tangled. The air where the tape leaves the recorder unit is ionized by strips of alpha-emitting polonium to remove electrostatic charges from the tape. Otherwise the tape might tend to cling to the glass panels. This method is satisfactory for tape speeds up to 8 feet per second.

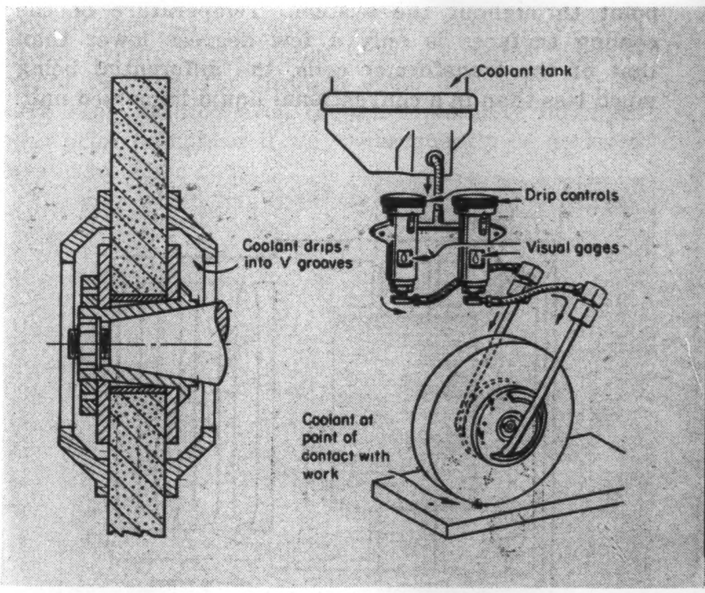
Adjustable-speed drive in which many parallel-connected motors operate at precisely the same speed is shown schematically at right. This system, developed by General Electric Co. for textile spinning machines, supplies adjustable alternating-current frequencies to synchronous motor drives on each machine section. This all-alternating-current drive insures speed control within one-tenth of one per cent over a 7:1 operating speed range. Probably the most precise drive that has been developed for parallel operation of motors, the system utilizes an electronically-regulated alternating-current adjustable speed motor which drives a variable-frequency generator trough a two-speed gear unit. The generator output is delivered direct to the synchronous motors.

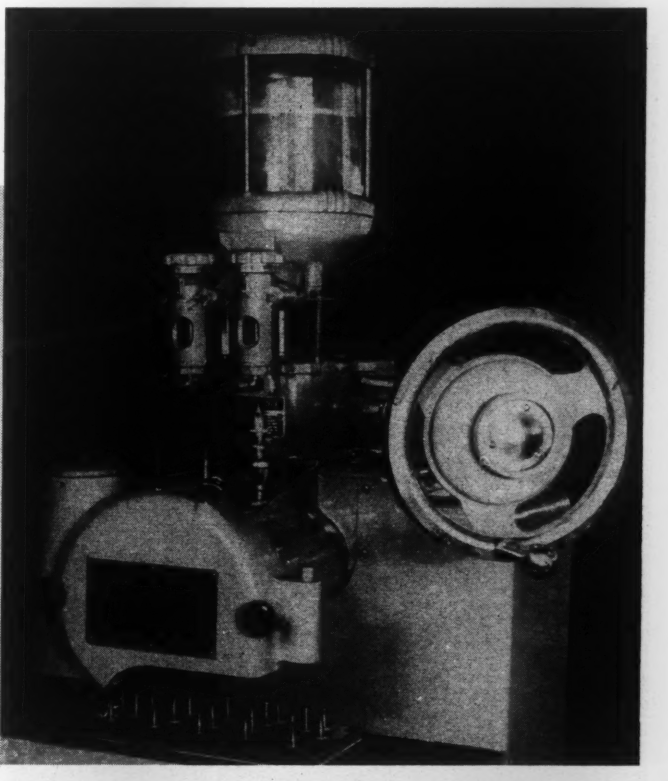
Requiring only about two-thirds of the floor space needed for a comparable direct-current drive, the system provides greater operational efficiency with fewer components. Lower maintenance expenses and savings in power consumption are additional advantages.


Incoming ac power
Exciter set
Electronic speed regulator
Main control panel
ac Motor
dc Gen.
Brush shifting pilot motor
Adjustable-speed ac motor
Two-speed gear box
Variable-frequency ac generator
Tachometer generator
Fractional-horsepower synchronous motors

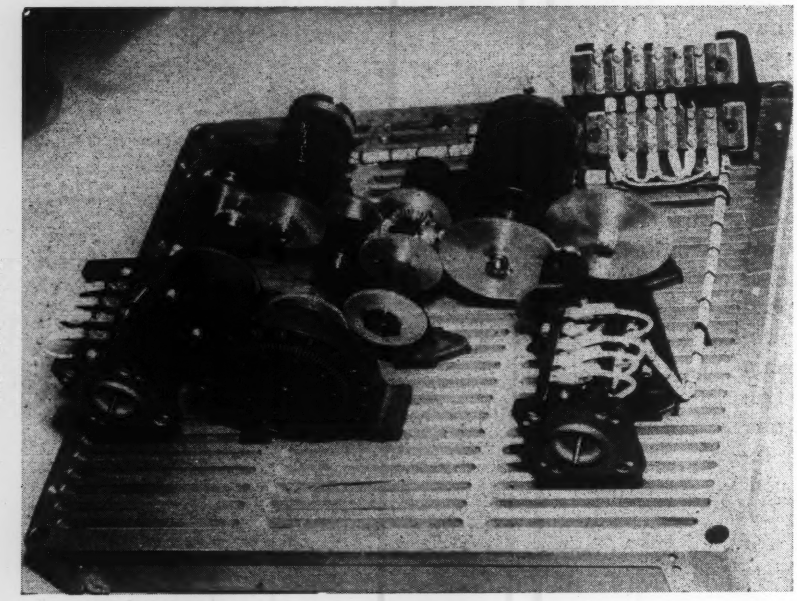
Cool grinding method of utilizing centrifugal force in the grinding wheel to feed coolant through the porous bonded abrasive, prevents overheating the workpiece and permits easier inspection of work. Developed by the DoALL Co., the grinder, below, directs the coolant to the cutting point of each abrasive particle. With the coolant in direct contact with the work at the source of the heat generated by grinding, the coolant effectively carries off excessive heat. In tests, work temperatures recorded have been as much as 600 F lower than when using conventional cooling, preventing cracking and work softening of hardened alloys.

As shown in the diagram, coolant drips into V-grooves in the flanges on both sides of the wheel. Centrifugal force feeds the coolant through the wheel to the periphery, atomizing the solution and flushing the wheel to prevent loading and glazing. A coolant tank, mounted above the wheel, supplies the coolant through drip valves and tubing to the wheel, cooling the wheel and work for more efficient grinding.


Coolant tank
Drip controls
Coolant drips into V grooves
Visual gages
Coolant at point of contact with work



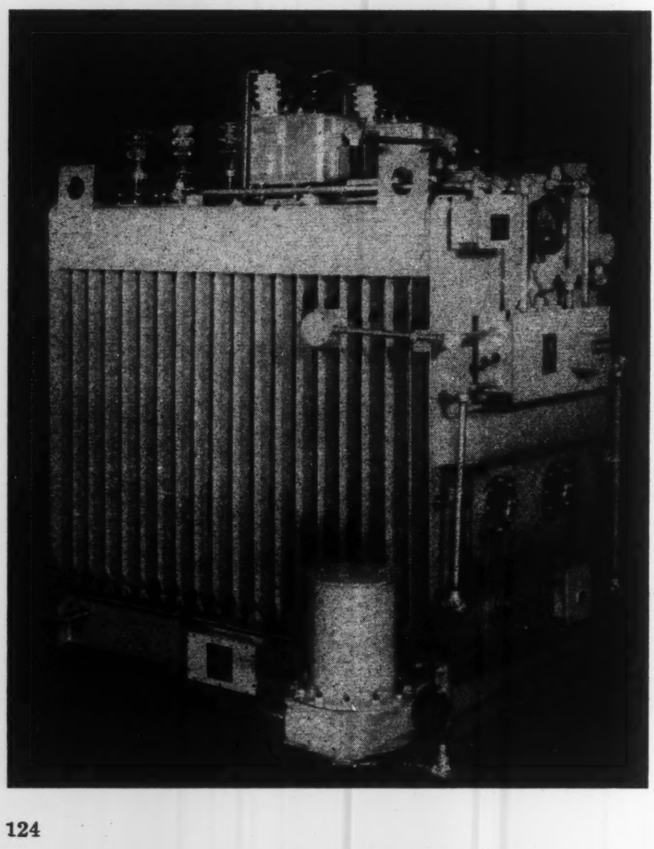
Ideas

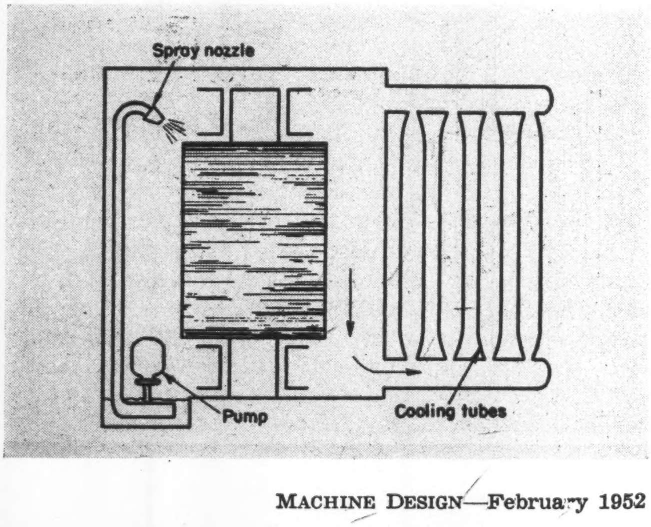


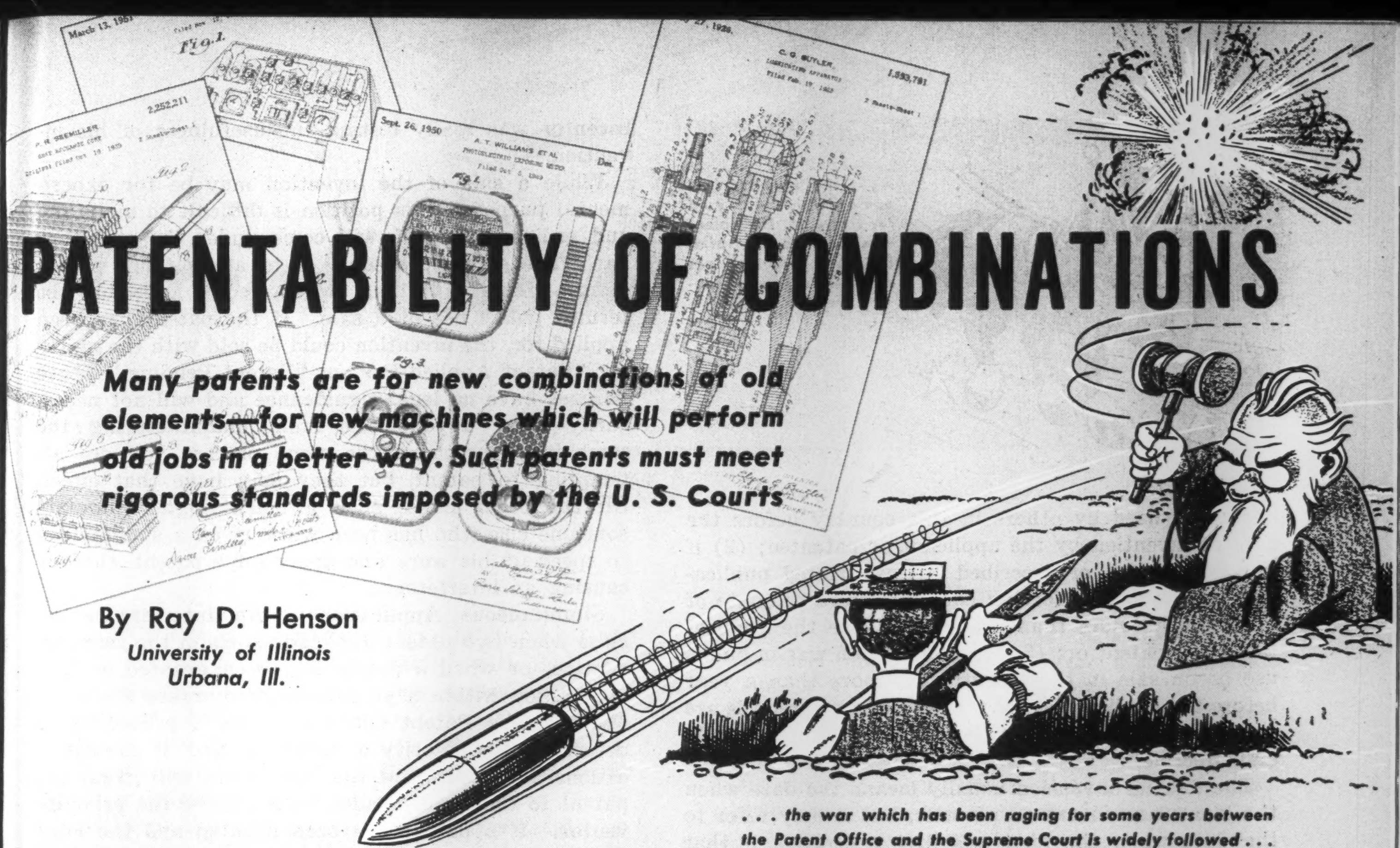
Breadboard electromechanical units, above, are useful for developing designs as well as for checking final production designs. Included among the units, developed for this purpose by Belock Instrument Corp., are high-speed magnetic clutches, precision gears and differentials, dial groups, mounting brackets, shafts, and grid plates. By using these parts, a setup may be made quickly and the accuracy of the results may be checked readily. Illustrated is a laboratory setup wherein two servomotors feed data through gear trains and magnetic clutches to a differential which combines these outputs for display on the dial.

Vapor cooling of units requiring heat exchangers may reduce their weight by about 30 per cent over that of equivalent liquid-immersed units if present development work, being conducted by Westinghouse Electric Corp., proves successful. The new technique utilizes the heat of vaporization of liquid fluorocarbons for cooling and the dielectric strength of the vapor for insulating the 500-kva transformer shown below. High molecular-weight fluorocarbons are promising for vaporization cooling for two reasons: They have a suitable boiling point and heat of vaporization, and they have a high dielectric strength and impulse strength at low pressures. In fact, at 60 cycles and atmospheric pressure, the dielectric strength is greater than that of transformer oil. They are not only nonflammable but also have fire extinguishing properties.

In the sketch, below, is illustrated the principle of vapor cooling applied to the transformer. A small pump forces liquid fluorocarbon from the sump to the nozzle, spraying the liquid uniformly over the core and coils. Taking its latent heat of vaporization from the coils, the liquid evaporates, filling the space in the tank with vapor. Forced upward through the cooling tubes, the vapor condenses and flows by gravity back to the sump. Condensation is accompanied by only a small change in temperature of the fluorocarbon, which remains near the boiling point throughout the system. Temperature of the cooling surfaces is only a few degrees lower than that of the transformer coils, the differential being much less than in a conventional liquid-immersed unit.







PATENTABILITY OF COMBINATIONS

Many patents are for new combinations of old elements—for new machines which will perform old jobs in a better way. Such patents must meet rigorous standards imposed by the U. S. Courts

By Ray D. Henson
University of Illinois
Urbana, Ill.

. . . the war which has been raging for some years between the Patent Office and the Supreme Court is widely followed . . .

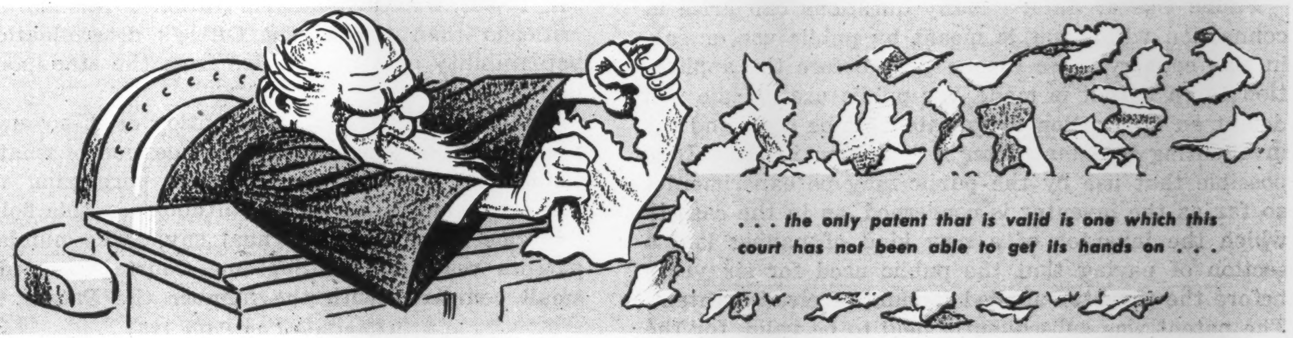
ANY investigation of patent requirements should start with the basic question—What is a patent, and what is it good for?

A patent issued by the United States Patent Office does not give the patentee the right to make, use or vend his invention if he did not have that right before the patent was issued. What it does give the patentee is the right to exclude others from using his patented device for a period of 17 years, if his patent is valid. At the end of the 17-year period, the patent may be used by anyone. But the mere grant of a patent by the Patent Office is no guarantee that the patent is valid, for through some oversight it may have been granted even though it actually infringes on a prior patent, or it may subsequently be declared invalid by some court.

The war which has been raging for some years between the Patent Office and the Supreme Court is widely followed. The Patent Office adheres closely to the requirements for patentability which can be rather mechanically administered, but the standard of invention which it requires for patentability is not sufficiently high to please the Court. Justice Jackson has said with some justification that ". . . the only patent that is valid is one which this court has not been able to get its hands on."[1]

What standards must an invention meet in order to be patentable? A patent may be granted, according to the statute, for "any new and useful art, machine, manufacture, or composition of matter, or any new and useful improvements thereof."[2]

Date of Invention: An invention must be new, and by statutory provision it is not new; (1) if it was



. . . the only patent that is valid is one which this court has not been able to get its hands on . . .

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[1] References are tabulated at end of article.

. . . the inventor laid paving which was used for six years. The patent was held to be valid, for the inventor was really testing his invention . . .

known or used by others in this country before the date of invention by the applicant or patentee; (2) if it was patented or described in any printed publication in this or any foreign country before the date of invention or more than one year before the application for a patent or; (3) if the invention was in public use or on sale in this country for more than a year before the application was made. These standards are ones which the Patent Office can apply most easily and effectively.

The date of invention usually means the date when the idea was reduced to practice, but it may refer to the date when the idea was first conceived, if that can be proved. To prove it inventors frequently resort to certain well-known practices. For example, it is worth-while to explain your ideas as early as possible, perhaps before they are fully worked out, to one or several witnesses and, as an added precaution, it is well to have them sign a statement that your invention has been explained to them. Frequently an inventor will write down his ideas, illustrate them if possible, have the paper witnessed or notarized, and then will send it by registered mail to himself, to be produced and opened when needed to show the date of invention.

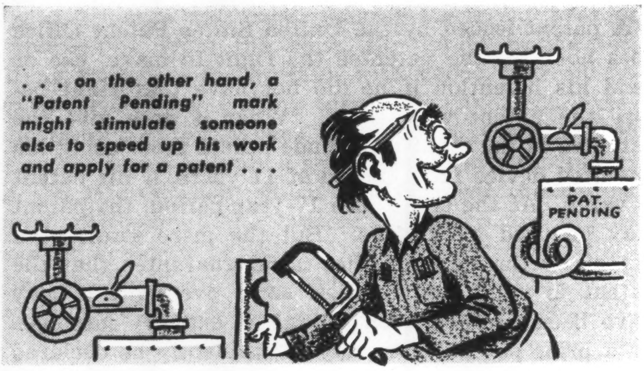
To anticipate an invention or invalidate a patent, prior knowledge or use of the invention must have been within this country—although an American cannot go abroad and borrow ideas in use there which are unknown here and which would be patentable so far as other provisions of the statute are concerned. Nor is it ordinarily fatal if someone in the United States once had the same idea, if there was no reduction to practice or if the idea was reduced to practice but unappreciated and subsequently abandoned. This attitude can be justified on the ground that the patent system is designed to protect the inventor who has benefited the public by disclosing his invention.

Public Use or Sale: Many questions can arise in connection with what is meant by public use or sale in this country more than a year before the application for a patent is made, for public use or sale will defeat an application for a patent or be a ground for invalidating a patent after it has been issued. It is possible that use by the public may be experimental so far as the inventor is concerned, as in the case in which the inventor of a new kind of paving laid a section of paving that the public used for six years before the inventor applied for and received a patent. The patent was subsequently held to be valid, for the inventor was really testing the usefulness of his invention.[3]

While a sale of the invention may be for experimental purposes, this position is difficult to maintain, and ordinarily a sale will come under the statutory bar. The safest procedure is to apply for a patent before doing anything which could possibly be termed public use or a sale. If the patent has been applied for, the invention could be sold with the marking "Patent Applied For" or "Patent Pending." These phrases have no legal significance and will not necessarily deter anyone else from manufacturing the same items or using the same process you are attempting to patent, but they may have that effect. On the other hand, such a mark might stimulate someone else who has been working on a similar idea to speed up his work and apply for a patent, thereby causing an interference.

Simultaneous Applications: An interference results when two patent applications claim the same invention, or when a patent has been granted and an application within a year thereafter makes the same claims. The Patent Office provides a procedure to determine the priority of invention and, if the applications are pending at the same time, will grant the patent to the applicant determined to be the prior inventor. If a patent has been granted and the later applicant appears to have been the first inventor, the Patent Office cannot cancel the first patent but may grant a second patent for the same invention, thus leading to an action for infringement to be tried in a federal court.

The requirements for patentability which have just been discussed may not always be simple to administer, especially if the question of prior public use or sale arises, but their administration is less subject to criticism than the Patent Office's determination of patentability of a new device from the standpoint of invention.



. . . on the other hand, a "Patent Pending" mark might stimulate someone else to speed up his work and apply for a patent . . .

The statute requires an invention or discovery if a patent is to be granted, and the question of what constitutes an invention may be most perplexing and is subject to individual views—although in this field the Supreme Court has the final say. The number of patents reaching the Supreme Court is exceedingly small compared with the number the Patent Office

(Continued on Page 195)

Thread Locking with Plastics

By S. S. Stivala*
Ordnance Corps Plastics Laboratory
Picatinny Arsenal
Dover, New Jersey

SELECTION of a particular type of locking fastener depends on the application, with due consideration to space limitations, accessibility, and permanence of assembly. A recent investigation has yielded a new development which offers certain advantages in commercial application—the use of liquid plastic compositions for locking threaded parts. These compositions form a series varying in strength so that the torque required for subsequent disassembly can be chosen as desired.

This article presents an analysis of the investigation which led to the development of certain polyester materials for thread sealing and locking. As a condensed guide for the practical use of design engineers, key information on the use of polyesters as thread sealers has been put together in the form of an appendix to this discussion.

Choice of Materials: Among the various materials available for examination as thread sealers, polyester compositions possessed several advantages:

1. Polyesters are available which polymerize at room temperature. As a result they harden and develop full mechanical properties without evaporation of solvent. A material which hardens by polymerization or by chemical reaction is preferable as a thread sealer because the ventilation in threads is poor and also because evaporation of solvent usually results in appreciable shrinkage.
2. Polyesters have the advantage of being "thermoset" polymers. The term thermoset applied to polymers which cure at room temperature may seem somewhat anomalous. However, this term has been adopted by the polymer fraternity to designate polymers which could more accurately be described as cross-linked or three-dimensional. In general, polymers of this class, whatever they may be called, are characterized by higher strength, more freedom from creep, and less sensitivity to temperature conditions than are polymers such as cellulose nitrate or unvulcanized rubber which might be used in lacquer-type sealers.
3. Under adverse conditions of storage, polyesters are known to be relatively stable in properties.
4. Polyesters are commercially available with a wide range of properties. These materials are standard products which are obtainable from a considerable number of plastics materials producers under a variety of trade names. They would be recognized by any of the suppliers if a request was made for them as polyesters.
5. Polyesters generally cost from $4.00 to $5.00 per gallon and have specific gravities from 1.0 to 1.2.

Properties of Polyesters: Most polyesters can be cured at room temperatures in a relatively short time. Catalysts, usually organic peroxides, are used to initiate the final polymerization or cure. The resins used in this investigation generally cured within 3 to 4 hours when catalyzed with 1 per cent by weight of methyl ethyl ketone peroxide.

All polyesters follow a general pattern during the final curing or polymerization process. The liquid polyester is first converted to a gel. Gelation is then followed almost immediately by further polymerization to the final infusible solid. It is during the last stages of polymerization that all the ultimate physical properties of the polyester are developed.

It should be pointed out that plasticizers generally are added to polymers to increase toughness and/or flexibility, and the incidental decrease in strength is accepted as an unavoidable simultaneous effect. On the other hand, with these thread sealers, plasticizers were added deliberately for the purpose of weakening the polymer.

Test Methods: Two different type polyester resins were investigated. Polyester A was a rigid resin and

Table 1—Effect of Catalyst Concentration

Catalyst Concentration % (by weight)	Torque* Polyester A (lb-ft)	Polyester B (lb-ft)
0.25	...	250
0.50	400	252
1.00	385	295
2.00	450	252
3.00	425	285
4.00	...	233

* Torque values are for 1-inch bolts at 77 F.

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* Now with Stevens Institute of Technology, Hoboken, New Jersey.

The views presented herein are those of the author and do not necessarily represent those of the Ordnance Corps.

Polyester B was a flexible resin. They list at $4.00 to $4.25 per gallon and have specific gravities of approximately 1.12.

Various combinations of the resins and plasticizers were applied to ½-in. and 1-in. bolts having National Coarse, Class 2 threads. Torque capacities after curing were measured for varying conditions of temperature and vibration.

Evaluation of Results: The main objective of this investigation was the selection of a material capable of mechanically sealing threaded parts together. Torque capacity is determined by several significant variables, which include the characteristics both of the material which is used as sealer and of the bolt and threads which are being sealed. The following table shows the torque capacities in lb-ft of both types of resins when used on the different size bolts (temperature of 77 F).

Composition	1-inch Bolt	½-inch Bolt
Polyester A	450 ± 40 lb-ft	55 ± 10 lb-ft
Polyester B	240 ± 90 lb-ft	30 ± 2 lb-ft

The relevant properties of the material used as sealer depend on the properties of the cured polymer itself and upon the modification in characteristics which is introduced by adding plasticizer. The relevant properties of the bolt and thread systems include the diameter of the bolt, class of thread, type of thread, nicks and irregularities that are found in threads due to machining and the contour and other dimensional characteristics of any threaded piece.

Two possible mechanisms are immediately apparent by which polyesters might provide the observed binding action: They might bind the bolts in place either by adhesive action, or simply by filling and obstructing the threads. On the basis of observations to date, it is believed that the first of these possible mechanisms plays only a minor part and that the binding action is due principally to the second mechanism. If for no other reason, the first mechanism seems improbable because polyesters have relatively low adhesion to steel.

Because the torque produced seems to be due mainly to mechanical obstruction of the threads it follows that a resin having high mechanical strength under compressive and shear stresses will produce high torque values. This was found to be the case, resins from the most rigid to the most flexible yielding torques of decreasing magnitude with decreasing rigidity; with polymers of this sort compressive and shear strengths generally decrease with decreasing rigidity and hardness. Rigidity and hardness in themselves probably have no effect on the torque which is produced, but these two properties simply parallel roughly the strength properties which actually do produce the torque resistance. Accordingly, it is not surprising to observe that decrease of torque is not a linear function of decrease in rigidity. Actually there seems to be a sharp drop in torque at the first decrease in rigidity. The most marked drop in torque usually coincides with the first, small percentage addition of polybutadiene or dimethyl phthalate, as shown in *Figs.* 1 and 2.

Effect of catalyst concentrations was investigated using concentrations of ¼ per cent to 4 per cent by weight. For all practical purposes it can be concluded that catalyst concentrations do not appreciably alter the torque. Average torque values obtained for different catalyst concentrations are shown in TABLE 1.

Another objective of this work was development of a series of sealers such that bolts could be fastened

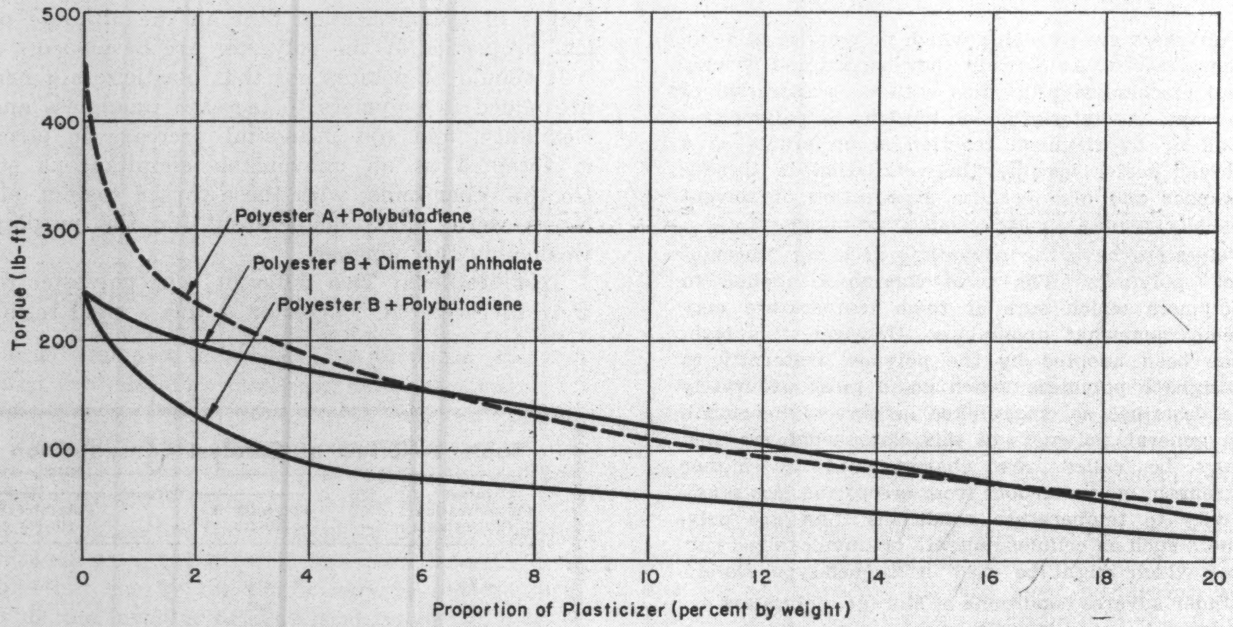


Fig. 1—Effect of addition of plasticizers, polybutadiene and dimethyl phthalate, on torque capacity of polyester compositions A and B. Tested on 1-inch bolts at 77 F

in place with various degrees of firmness and torque resistance. This has resulted in the specifying of seven sealer compositions to provide torque resistance from very high to very low. It would probably have been possible to find seven different polyesters, of appropriately varying strengths, to cover this range. However, essentially the same result could be accomplished by using fewer polyesters and modifying these with added plasticizer, with advantages in purchase, storage, and utilization. The seven sealer compositions are shown in TABLE 2, which also lists representative torque values for a 1-in. bolt using a ¾-in. engagement.

Several Factors Influence Torque

Polybutadiene used as the plasticizer worked well with either the rigid or the flexible resin. It is conceivable that the addition of polybutadiene served not only as a weak filler in the mechanical sense but also to some small degree as an unsaturated compound capable of entering into the polymerization reaction. Apparently, in the curing reaction, the polybutadiene modified the properties of the pure resin into a material that was weakened by introducing a longer chain cross-linking agent.

Dimethyl phthalate and ethyl lactate similarly weakened the polymer, but only in the case of the flexible type resin. TABLE 3 shows the effect of ethyl lactate.

Concentrations of ½ per cent and 1 per cent carbon black with either polyester A or B failed to lower torque.

National Coarse, Class 2 threads only were used in this investigation. Accordingly, these results and conclusions are valid for Class 2 fits and would have to be modified in connection with other fits in accordance with subsequent investigation.

Up to this point discussion has centered on the variables affecting initial torque. Other factors can also affect retention of torque resistance and hence would affect durability as distinct from initial strength. These factors include weather, temperature and vibration.

Most polymeric materials when exposed to low temperatures, such as −65 F become increasingly strong as well as increasingly hard and brittle. Accordingly, as would be expected, higher torque resistance was observed at low temperatures. Also, at low temperatures all the polymeric compositions evaluated tended to approach the same torque resistance.

At the other end of the scale, most polymeric materials, when exposed to higher temperatures, such as 160 F, tend to become weaker and softer. This is definitely true for thermoplastic materials, and to a lesser degree is also true of thermosetting materials, the degree of weakening depending upon the chemical constitution of the polymer. Since the polyesters considered in this investigation are thermosetting, reduction of stress will not be extreme. As a result, the torque obtained at 160 F for any given bolt and resin was appreciably lower than at room temperature but was not so low as would be expected if a thermoplastic material had been used (TABLE 2 torque values are illustrative).

It was observed that as the temperature increased the reproducibility of torque values decreased. Since torque is resisted partly by mechanical irregularities even in the absence of any sealer, the erratic results may be partly due to the increasing dominance of

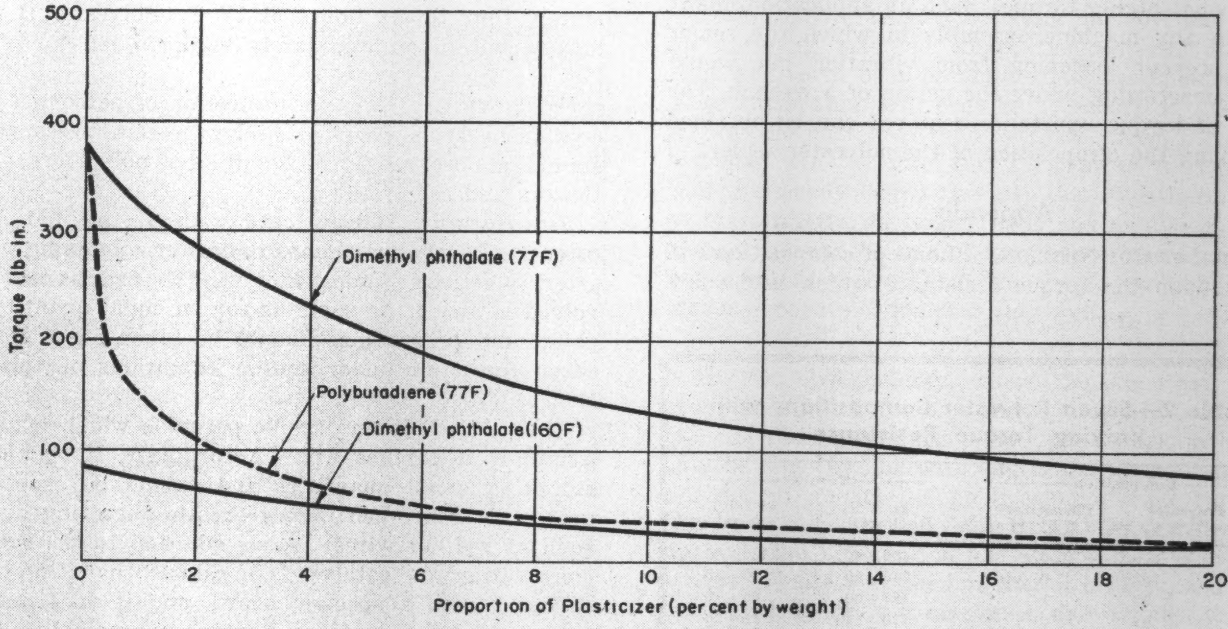


Fig. 2—Effect of addition of plasticizers, polybutadiene and dimethyl phthalate, and temperature on torque capacity of polyester B as tested on ½-inch bolts

mechanical irregularities in torque production as the sealer becomes less important.

Because many threaded parts are exposed to varying conditions of weathering, a series of bolts sealed with four different resin compositions was subjected to temperature cycling, consisting essentially of exposing the bolts to −65 F for 8 hours followed immediately by 160 F and 90 per cent relative humidity for 16 hours. This was repeated for a period of six days. Under such adverse conditions the torque resistance of bolts was found to be totally unaffected.

Within experimental limits and for all practical purposes, it can be stated that adverse conditions of continuous vibration do not generally alter the torque for any given bolt and resin appreciably. TABLE 4 shows comparative torque values for four different compositions after subjection to vibration and to temperature cycling.

One precaution must be kept in mind in connection with the curing of polyesters. These materials will not cure along surfaces which are in contact with copper, brass, or lead or in contact with rubber compositions which contain sulfur. Accordingly, the sealers would not cure if used with brass bolts. If, for example, rubber or lead washers were used in conjunction with steel bolts, the polyester would remain sticky and would not cure where in contact with the washer but would be expected to cure normally in the threads slightly removed from the washer.

Conclusions: It has been found that polyesters provide remarkable and controllable resistance to torque in threaded parts. The stronger polyesters produce very high torque, making the disassembly of a one-inch-diameter bolt very difficult. In some applications this is desirable, while in others a somewhat different result may be preferable. It may be desired that a threaded part be capable of withstanding a limited, specified torque, but be capable of unscrewing under a somewhat higher torque. Such an application might occur in any machine assembly in which the sealer would prevent loosening from vibration but would permit unscrewing under the action of a wrench. The degree of torque resistance required can be obtained by varying the composition of the polyester sealer.

Appendix

CHOICE OF COMPOSITION: Choice of composition will depend upon the torque resistance which is desired.

Table 2—Seven Polyester Compositions with Varying Torque Resistance

Composition			Torque*	
Type	Polyester (% by wt.)	Plasticizer† (% by wt.)	at 77 F (lb-ft)	at 160 F (lb-ft)
A	100	0	450±40	425±80
B	100	0	240±90	95±15
B	99	1	180±50	65±40
B	95	5	170±110	45±20
B	90	10	120±70	40±5
B	85	15	70±50	40±5
B	75	25	25±11	25±12

*For 1-inch bolts with ¾-inch engagement †Dimethyl phthalate

TABLE 2 shows the torque values which can be expected with 1-in. diameter bolts with seven different sealer compositions. Additional intermediate values could be obtained with corresponding intermediate compositions. However, the torque values listed are believed to cover relatively well the range that will generally be required.

PREPARATION OF SEALER: The sealer composition will consist of polyester resin to which catalyst has been added and to which plasticizer may have been added. The polyester should be weighed with an accuracy of ±1 per cent of the weight involved and the catalyst and plasticizer should be weighed with an accuracy of ±5 per cent of the weight involved. The plasticizer and catalyst can be added to the polyester and all three then mixed. Mixing should be sufficient to secure uniform distribution of both plasticizer and catalyst throughout the whole.

APPLICATION OF SEALER: The catalyzed composition is applied to threaded parts by brush or by dipping the end of the bolt in a container of the thread sealing composition. In either case the composition is applied to the bolt only.

Table 3—Effect of Ethyl Lactate

	Average Torque*	
Ethyl Lactate (% by weight)	Polyester A (lb-ft)	Polyester B (lb-ft)
1	460	293
5	410	176
10	373	103
20	...	27

*Torque values for 1-inch bolts

CURING: Polyester A will harden within approximately four to six hours at 77 F. Polyester B will harden within approximately eight to ten hours at 77 F.

PRECAUTIONS: For the protection of personnel and equipment from possible injury certain precautions should be observed in the handling of polyesters, plasticizers and catalysts:

Fire Hazard: In connection with the original polyester or the sealing composition after combining polyester, plasticizer, and catalyst, the fire hazard involved is about the same as for an equal quantity of paint, and precautions should be taken as would be taken for paint under similar conditions of application.

The catalyst is an organic peroxide which may detonate if it catches fire. Accordingly, it should be stored in small quantities and should be especially protected from open flames or other igniting agents such as red-hot wires. After addition to the sealing composition, the catalyst is so diluted that it no longer constitutes a special hazard, and it does not increase the hazard of the mixture appreciably. During curing, the peroxide is entirely consumed and therefore disappears.

Ventilation: Although polyesters have a moderately strong odor which is found by some persons to be

Table 4—Effect of Temperature Cycling and Vibration

Composition			Average torque*			
			Static		Vibrated	
Type	Polyester (% by wt.)	Plasticizer (% by wt.)	At 77 F (lb-ft)	Temp. Cycle (lb-ft)	At —65 F (lb-ft)	At 160 F (lb-ft)
A	100	0	450	493	445	420
B	100	0	240	220	253	293
B	90	10†	120	133	130	113
B	90	10‡	57	57	30	30

*For 1-inch bolts †Dimethyl phthalate ‡Polybutadiene

seriously objectionable, the materials are not especially toxic. Ventilation equal to that when the same amount of paint is used should be adequate.

Dermatitis: Polyesters have not been found to cause dermatitis in general, even among operators who have their hands in the material much of the time. Accordingly, problems resulting from dermatitis should not be expected. However, it must be remembered that exposure to organic vapors or to volatile liquids constitutes abnormal exposure for the human skin and, accordingly, it should be expected that an occasional person will be encountered who may have a more or less adverse reaction to these sealers.

Skin burns: Peroxides are strong oxidizing agents capable of causing severe burns to the unprotected skin. Accordingly, contact of skin with undiluted catalyst should be avoided.

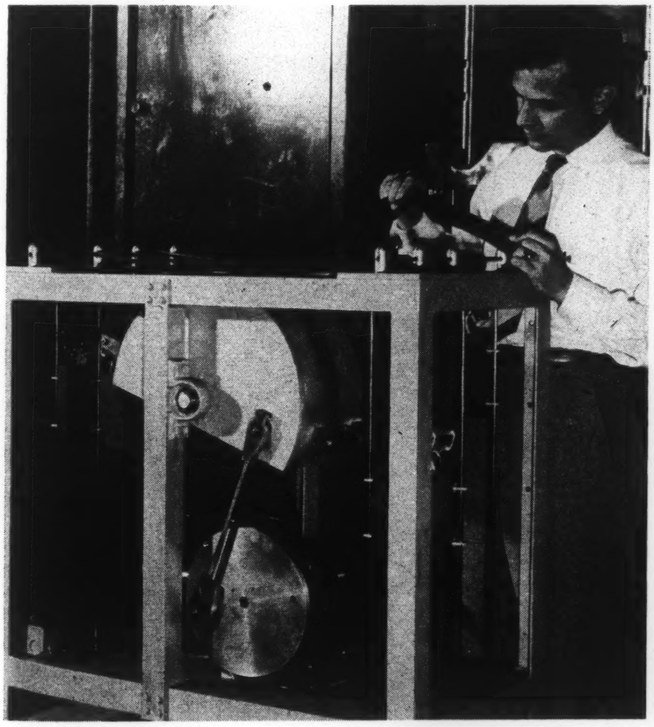
POT LIFE OF CATALYZED RESIN: The working life of Polyester A after mixing is approximately two to three hours at room temperature. For Polyester B under similar conditions, working life is approximately 2½ to 3½ hours. After this time, the sealer composition becomes too viscous for satisfactory spreading.

CLEANING OF UTENSILS: Polyesters can be dissolved in toluene, benzene, acetone, etc., providing the resin has not gone beyond the gel stage. On the other hand, the cured, hard sealer is unaffected by any solvents. The hardened material is normally removed from its container by freezing. The resin contracts considerably during freezing and can often be removed simply by inverting the container.

STORAGE CONDITIONS: Even without the catalyst added, the polyesters will gradually polymerize at room temperatures and, after about six to eight months at 75 F will become too viscous for convenient use. Accordingly, it is preferable to store the polyesters at about 35 F or lower.

Resin Impregnation Improves Harness

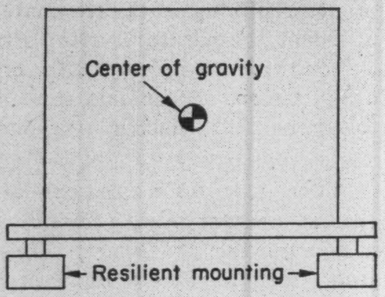
INSURING the safety of fliers who must "hit the silk" in an emergency, and at the same time saving the United States Air Force over a million dollars a year are the results of a process for treating the ribbon-like strands of nylon webbing used in parachute harness manufacture. The Materials Laboratory, Air Materiel Command, devised the process of pressing poly-vinyl-butyral, commercially known as Merlon-BR, into the webbing. The resin does not penetrate the nylon fibers but acts more like an adhesive, keeping them from becoming separated and fraying.



Tests of the treated webbing include the use of an abrading machine where the material is pulled back and forth over parachute harness buckles many more times than will ever be necessary in use. Outlasting the untreated type by three times, the treated webbing will be safe for 15 months in harnesses that previously lasted five months. Weathering tests at both Wright-Patterson AFB and at a test station at New Mexico State College, for periods of one and two months, showed that the treated webbing withstands exposure to weather very well.

"In our own country, where the American dream of a rich, full life for all our people is still unfulfilled, there is enormous work to be done—work which can only be done by and with engineers. Greater production of all goods, the application of new forms of energy to industry and daily living, the enrichment of the soil, the bringing to use of new metals and new synthetic materials, the building of bridges, and dams, and skyscrapers, and machines, and articles that are sold over counters in the thousands of stores in our country—these, all of these, are the works of the hands and minds of engineers."—LEO J. PANTAS, *works manager, Yale & Towne Mfg. Co.*

Fig. 1—Schematic arrangement of conventional type vibration isolation mount. Note center of gravity location above spring mounting level



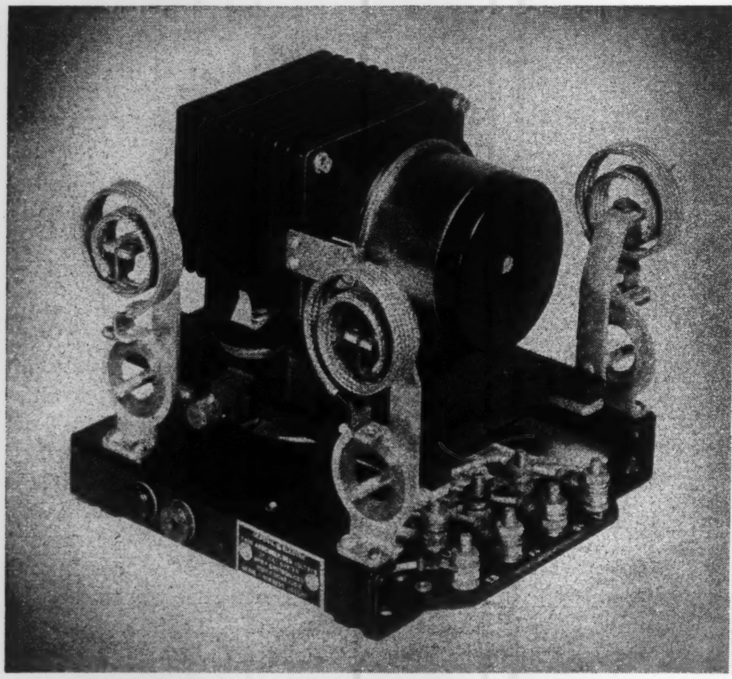
VIBRATION

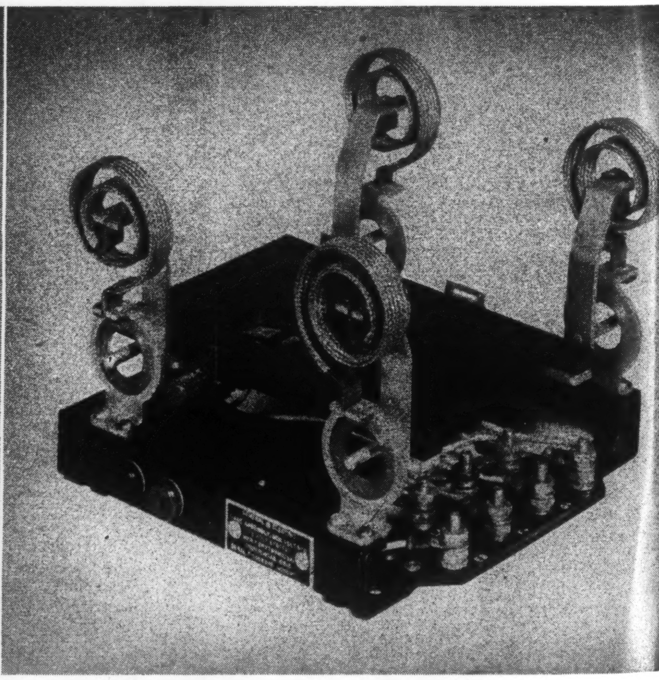
How new center-of-gravity type mount was designed to provide uniform protection for precision instruments used in aircraft regardless of positions encountered in flight

SWIFT advances in aircraft technology keep aircraft flying higher and faster. Severe vibration conditions encountered today, combined with such requirements as operation under extreme temperature conditions and resistance to shock, have created the necessity for greater improvements in vibration isolation mounts. To meet these conditions, a new center-of-gravity type vibration isolation mount has been designed primarily to protect voltage regulators on aircraft from the effects of shock and vibration.

The use of spring suspensions has been the principal method of isolating vibration. Spring mounts currently used, however, protect the devices only when mounted in a horizontal plane. Furthermore, in the conventional type mounting arrangement, *Fig.* 1, the center of gravity of the device to be protected is above the suspension spring level in most cases. In aircraft applications it is highly desirable to have a vibration isolation mount which is equally effective regardless of the plane in which the device is mounted or the direction in which the shock or vibration is transmitted.

In the General Electric center-of-gravity mount, shown in *Figs.* 2 and 3, the movable ends of the four spiral springs are equidistant from and in the same plane with the center of gravity of the device to be protected. This mount is ideally suited for aircraft applications, not only because of the mounting arrangement, but because of the characteristics of the spring suspension. Each of the four springs deflects substantially the same amount, regardless of the plane





ISOLATOR

By J. S. Zimmer
Control Department
General Electric Company
Schenectady, N. Y.

in which the device is mounted, thus enabling the mount to be equally effective in all positions. The springs also are designed to provide excellent vibration damping characteristics making the mount suitable for wide frequency bands of operation.

Performance requirements as outlined in Army-Navy specifications 17R21 and AN-B-30 were followed carefully in the design of this protective device. Stated in condensed form, the following factors played important roles in the design throughout the entire development:

Vibration Absorption: Test frequency, 20 to 200 cycles per second. Peak-to-peak displacement, 0.060-in. from 20 to 60 cycles per second. Displacement equivalent of $10g$ from 60 to 200 cycles per second. Transmissibility to device not to exceed $1g$ when

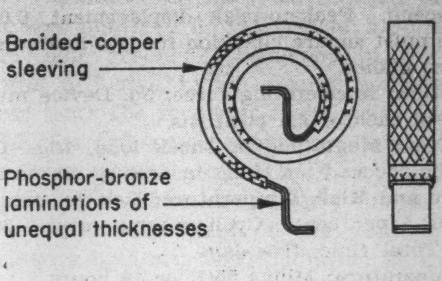


Fig. 4—Above—Spiral spring, which when properly designed, will deflect substantially the same in any plane under a given load

Fig. 5—Below—Calculated acceleration curve indicating vibration transmissibility of the new type vibration isolation mount considering only the natural frequency of the mount when loaded

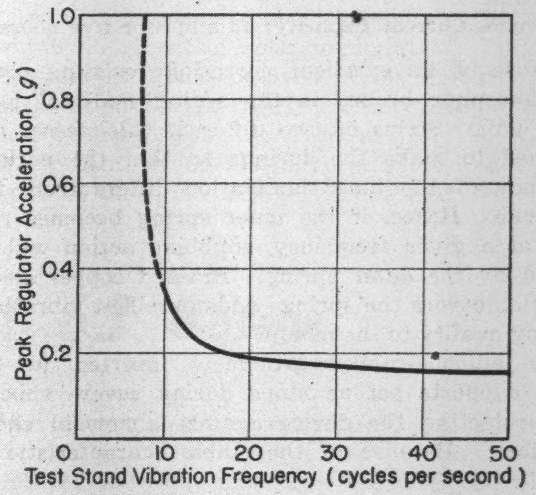


Fig. 6—Below—Vibration absorption characteristic of the mount plotted with data obtained from the test setup shown in *Fig.* 7

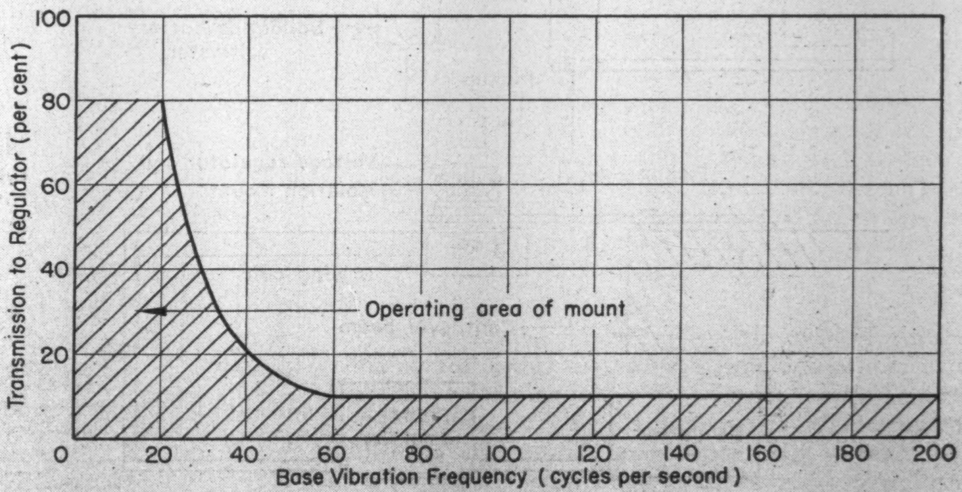


Fig. 2—Extreme left—Aircraft voltage regulator mounted in the new center of gravity type isolator. The true center of gravity of the suspended mass is located centrally with respect to the centers of the four springs

Fig. 3—Left — Construction details of the isolator base assembly with the voltage regulator removed. Note quick-mounting facilities for attaching the regulator, and the silicone-rubber grommet type shock cushions

vibrated in each of three planes.

Vibration Endurance: Test frequency, 10 to 55 cycles per second. Peak-to-peak displacement, 0.060-in. Device must endure vibration for two hours in each of three planes.

Acceleration: Accelerating force, 5*g*. Device must be tested in each of six positions.

Shock Test: Magnitude of shock load, 10*g*. Device must be shocked ten times in each of six positions.

Humidity and High Temperature: Relative humidity, 95 plus 5 per cent. Cycling temperature, 38C to 71C. Total time, five days.

Low Temperature: Minus 55C for 48 hours.

Salt Spray: 25-hr salt spray per specification QQ-M-151.

Sand Resistance: Temperature, 21C to 50C. Relative humidity, 10 per cent, max. Sand concentration, 1.0 ± 0.1 gram per cubic foot of air. Air velocity, 100 fpm ± 10 per cent.

Fungus Growth: Relative humidity, 95 plus 5 per cent. Temperature, 30C ± 3. Device must be subjected to one fungus from each of four groups.

Dielectric Strength: Test voltage, 500 v rms for one minute between circuits, and from circuits to ground.

Maximum Current Capacity: 15 amp, for five hours.

Because of its excellent corrosion resisting property, phosphor bronze is the spring material used in the unit. Strips of two different thicknesses are combined to make the springs so that the natural frequency of the inner lamination differs from the outer one. Hence, if the inner spring becomes resonant at a given frequency, snubbing action will be effected by the outer spring. Braided copper sleeving which covers the springs adds excellent vibration-damping quality to the mount.

Four silicone-rubber grommets inserted in the spring supports act as stops during severe shocks, thus protecting the device against abnormal shock conditions. Because of the stable characteristic of silicone rubber at low and high temperatures, effective cushioning action is obtained over a wide temperature range.

Electrical connections are made from the movable base to the fixed terminal board by means of flexible wires having generous loops to avoid the possibility of less effective vibration isolation because of wiring stiffness. A positive, thumbscrew-type locking clamp is provided so that the plug-in type voltage regulator may be removed from the base by simply loosening the knurled knob of the clamp. Test jacks and an equalizing potentiometer mounted on the rigid base are readily accessible.

Primary consideration in designing the vibration isolation mount was to design a spring which would deflect substantially the same amount in all planes under a given load. A spring configuration as shown in *Fig.* 4 was found to possess this characteristic. The relationship between the number of turns, the thickness and width of the laminations, and the general shape of the spring were factors considered in order to obtain the proper deflection characteristics.

For evaluation of the best possible performance of such a mount, when subjected to a simple harmonic motion and considering only the natural frequency of the mount when loaded, the peak acceleration transmitted to the voltage regulator was calculated as a function of the forcing frequency.

Assuming no damping, the peak acceleration a_o as a fraction of g is given by the well-known relation:

$$a_o = \frac{\dfrac{x}{g}}{\left(\dfrac{1}{\omega_n}\right)^2 - \left(\dfrac{1}{\omega}\right)^2}$$

where x = amplitude of base vibration, inches, g = acceleration due to gravity, in. per sec^2, ω = fre-

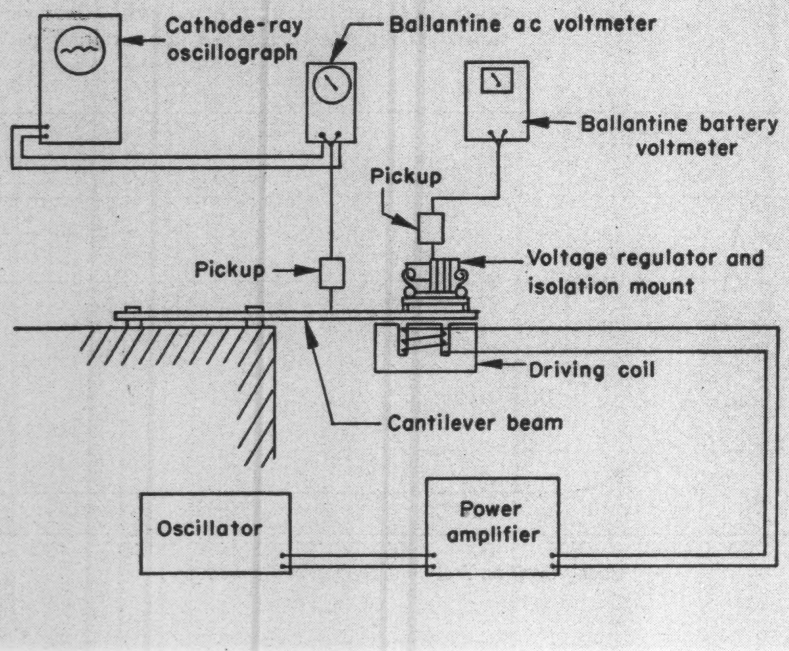


Fig. 7—Schematic arrangement of test setup employed to determine the actual isolating efficiency of the new regulator mount

quency of vibration of base, rad per sec, and ω_n = natural frequency of vibration of mounted regulator, rad per sec.

Assuming a vibration displacement of 0.0312-in., the weight of the regulator as 3.5 lb and the deflection of the mount as 0.187-in. when loaded, the curve in *Fig.* 5 was calculated showing the peak acceleration, *g*, transmitted to the voltage regulator as a function of the forcing frequency in cycles per second. From this graph a ratio of input to output acceleration was obtained, giving a measure of the effectiveness of the mount.

Since these calculations did not take into account the effect of resonant frequencies of the spring suspension it was found that in order to approximate this ideal condition, a highly damped spring suspension was necessary. It was then determined, largely by experiment, that a laminated structure of the spring using two different thicknesses eliminated to a great extent some of the peak accelerations of the voltage regulator. This arrangement combined with the damping effect of the braided copper sleeving resulted in a characteristic curve as shown in *Fig.* 6.

For determining the degree of isolation of the mount at different frequencies and amplitudes, the test setup outlined in *Fig.* 7 was used. To obtain straight line or linear vibrations over the frequency range specified, the complete voltage regulator assembly was mounted on a cantilever beam and the beam force-driven by an electromagnet placed underneath. Variable frequency current to energize the magnet was obtained from a power amplifier and oscillator. The resonant frequency of the cantilever beam was adjusted by changing the overhang, and for these tests the resonant frequencies used were 40 to 120 cycles per second, approximately.

To measure the vibration isolation efficiency of the suspension, the vibration velocity of the cantilever was compared with that of the voltage regulator. Velocity pick-up units were mounted at the approximate locations shown, but since the velocity pick-up on the beam was closer to the support than the one on the regulator, its readings had to be increased by the ratio of the true amplitudes of beam vibration.

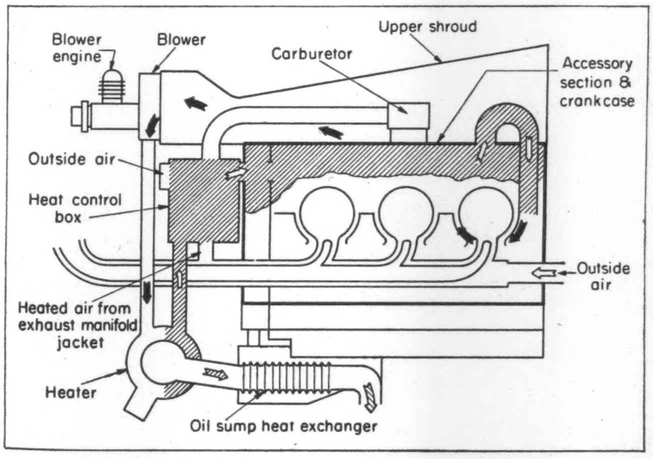
Signal voltages from the two vibration velocity pick-up units were measured by vacuum tube voltmeters and the wave shape of the beam vibration velocity was checked on a cathode-ray oscillograph. Measurements were taken every two cycles per second from 20 through 200 with the voltage regulator in each of three test positions. The test setup proved to be a very effective tool throughout the development of the vibration isolation mount.

Design principles involved in the unique construction of the new type mount are now being adapted to other aircraft applications because of the wide frequency band of operation permissible and the high degree of vibration isolation made possible.

Engine Starts at 65 Below

FOR starting in temperatures as low as 65 degrees below zero, new light-weight gasoline engines developed by Continental Motors Corp. contain built-in heating systems. The engines, in 5 to 250-hp sizes, are prewarmed by gasoline heaters with a 50,000 Btu output.

During the engine warm-up period, a blower driven by a one horsepower blower engine, circulates fresh air through the heater. The heated air is directed into the accessory section and crankcase, where it warms the main bearings. It then flows around the exterior of the cylinders to the upper shroud, after which it returns to the blower inlet and is recirculated.



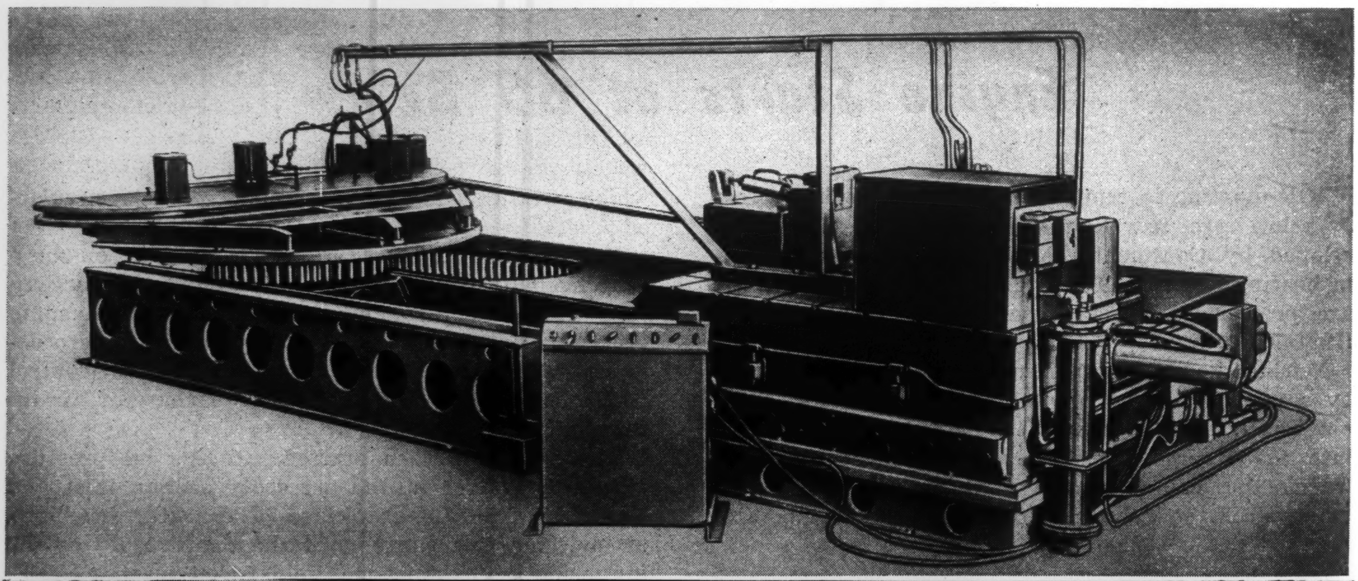
Heated exhaust gases flow through an oil-sump heat exchanger, to heat the oil around the suction-tube inlet and throughout the sump. When sump lubricating oil has reached a temperature of zero degrees F, a solenoid opens a valve in the heat-control box to provide heated air for the carburetor air intake.

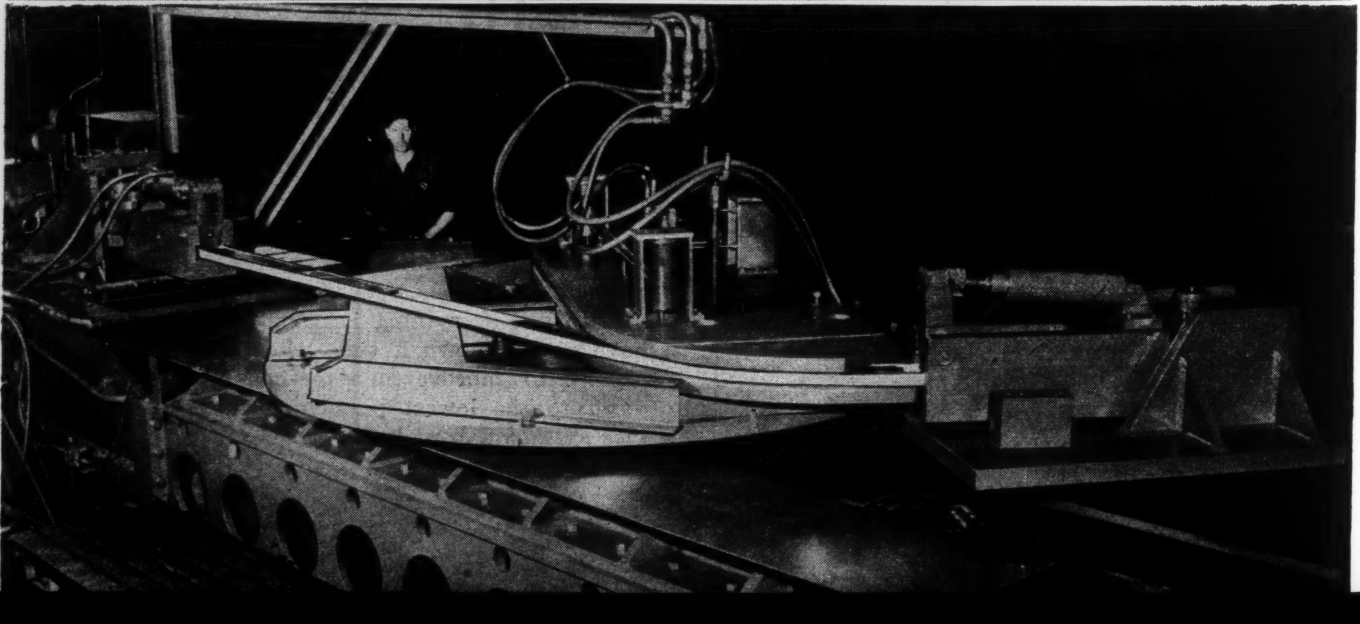
The engine is then started. Engine oil pressure closes the valves at the accessory section inlet and the outlet from the crankcase. The heater and blower continue to operate until the temperature of the air inside the exhaust manifold jacket reaches 100 F. The valve from the heater to the carburetor air mixing valve then closes automatically and the heater and blower are turned off. Heated air from the exhaust jacket is then blended with cold air in the heat-control box to supply 60 F air to the carburetor.

"Engineers have never been able to let up in their search for better materials, better design and better product performance, even when industry has been able to sell everything it made. Manufacturing men have never known a time when they weren't being pressed to improve their methods and to keep costs down to the lowest possible level."—BENSON FORD, *vice president, Ford Motor Co.*

Bending Machine Exerts Constant Stretch Load

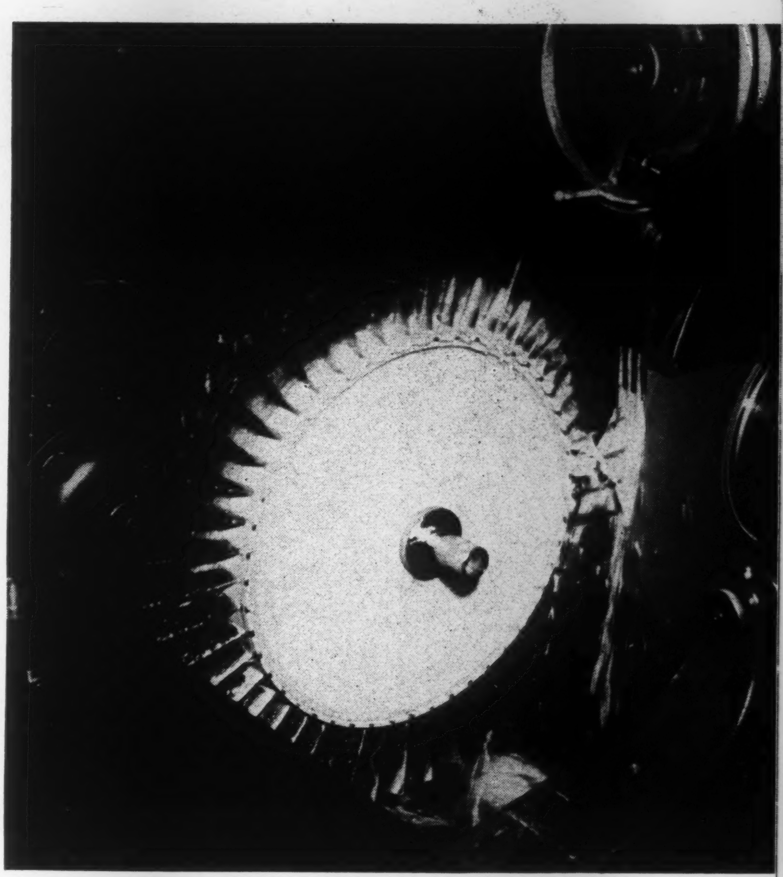
EMPLOYING an entirely new design principle, the stretch-type bending machine, below, is capable of stretch forming sections of up to 2½ sq. in. cross-sectional area. Automatic control enables exact duplication of parts formed by the new machine, and continuous production from coiled stock is made possible by the open construction. The slide-mounted rotary work table which carries a forming die and clamp is geared to a sliding rack, the two parallel sliding members being operated by separate hydraulic cylinder arrangements. One end of the stock is clamped in a swivel type stationary chuck and the other end is held in the forming die clamp. Hydraulic force exerted on the rack maintains a predetermined tensile stress in the section during forming. The table operating piston then pulls the rotary table slide toward the head end of the machine, and work table rotation is brought about by virtue of the rack and gear engagement to wrap the highly stressed stock around the forming die. As the die contour contact with the work changes during the wrap-around procedure, the hydraulic pressure maintained in the rack cylinder automatically repositions the rack to maintain constant tensile stress in the stock. Lower photograph shows the machine in an intermediate table position during a typical forming operation. The operating control stand is cable connected to the machine, enabling it to be positioned at the most suitable vantage point for different setups. Struthers Wells Corp., Machinery Div., build the Roller Table machine in tensile capacities of 12½, 25, and 65 tons.

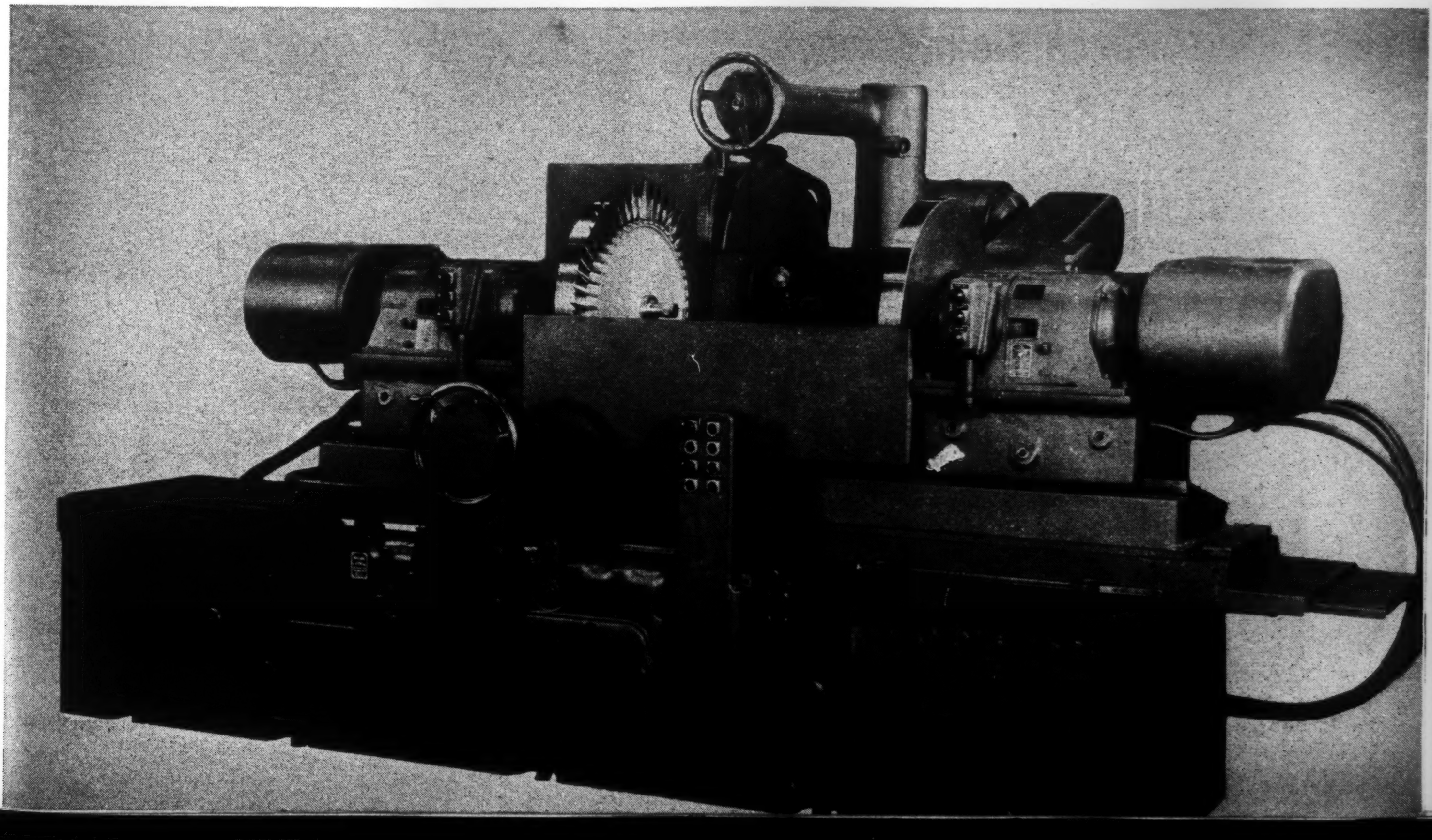


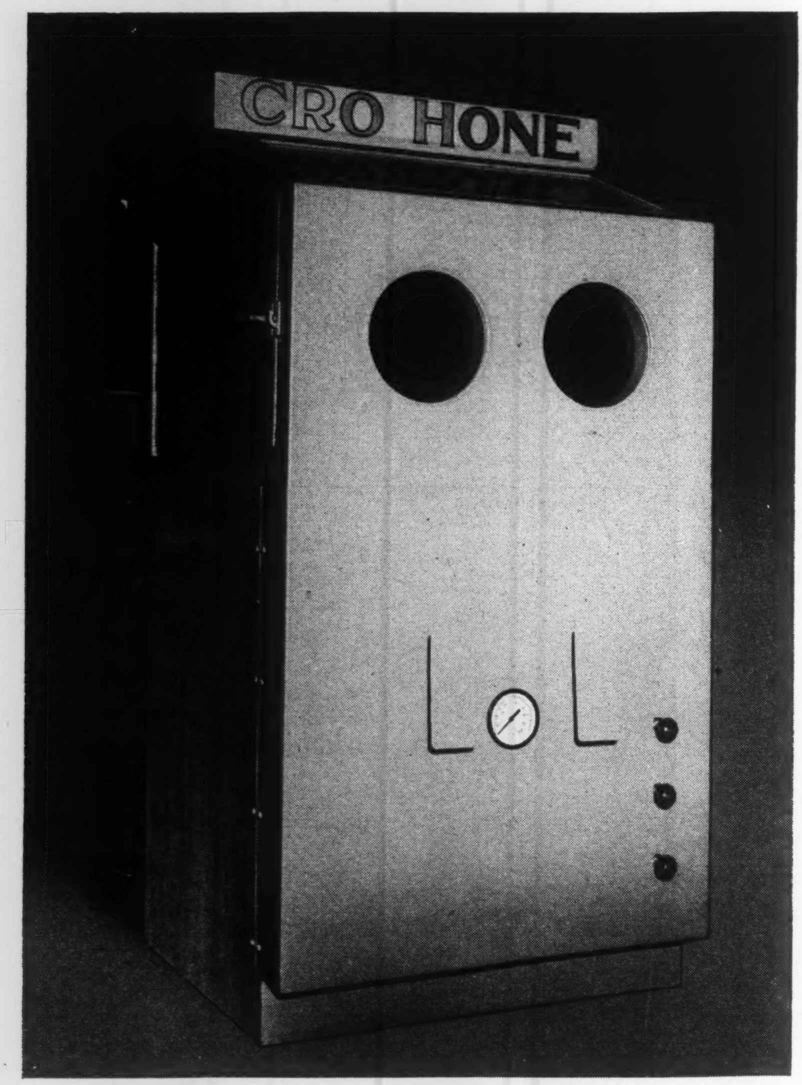


Twin Headstocks Save Time

PRODUCTIVE machine time is increased greatly in the cylindrical grinder shown below by the use of twin headstocks equipped with hydraulic chucking. This arrangement plus electrohydraulic control of the grinding cycle from start to finish makes possible, in effect, one machine and operator performing the work of two. Designed primarily for grinding the blade tips of turbojet engine rotors, the one headstock may be unloaded and reloaded while the grinding operation is underway at the other station. After completion of a grinding cycle, the work carriage traverses to the alternate station where the cycle again proceeds automatically, provided the headstock has been loaded. To equalize grinding wheel wear and to improve surface finish quality, the grinding wheel and spindle are reciprocated axially about one-half inch while grinding. A table mounted diamond holder with micrometer adjustment enables truing the wheel face accurately in relationship with the work centerline. This feature, coupled with electrically controlled sparkout timing at the conclusion of grinding feed eliminates the usual practice of sizing the work by micrometer caliper, the use of which, in this instance would be rather awkward because of the nature of the work surface. To provide good stability in view of the large swing capacity, the carriage guideways are spaced widely apart in the 30 x 48 type CHW plain grinder built by Landis Tool Co.







Good Visibility and Control Aid Wet Blasting

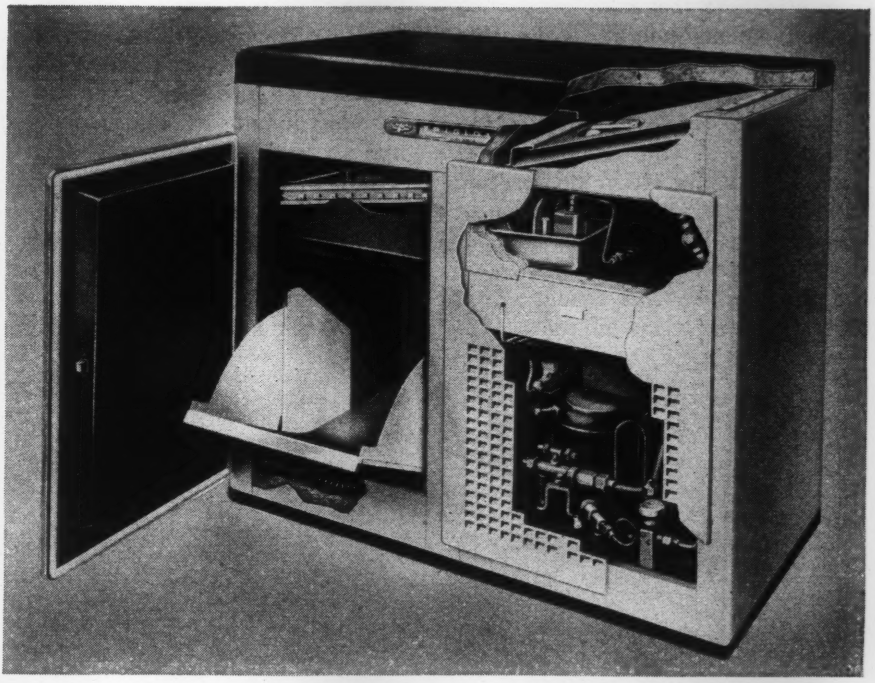
DESIGNED for rapid wet abrasive blasting, the unit illustrated left is arranged for easy and convenient operation. All valves and controls are located in the front panel which is recessed at the bottom to provide toeroom. Knee-operated actuators control the high-capacity blast valve and observation window washer valve. Interior lights are safely shielded from the blast by dual glass protective covers. The safety glass observation window and access doors are sealed with rubber strips to confine the abrasive slurry. For good work visibility, a 600 cfm exhaust blower equipped with stainless steel filter removes vapors at work table level rather than at the top of the cabinet. Instead of mechanical pumps, siphon air-jet guns draw the slurry from a 35-gal hopper and direct it to the work surface. Air discharge from nozzles in the hopper agitates the mixture to maintain uniform suspension of abrasive particles. Built by Cro-Plate Co. Inc., all parts of the unit in contact with abrasive slurry are stainless steel or brass to eliminate corrosion and contamination of the abrasive fluid mixture.

Punch Reinforces Ring Holes

LOOSE-LEAF sheets can be reinforced and punched simultaneously in a new office machine, right, designed to eliminate the almost always inevitable and tedious time-consuming task of applying reinforcing patches. Adhesive-backed tape is fed automatically from rolls, cut, folded, applied to the paper and punched in a one motion of a single operating lever. Cost of reinforcing papers with the device is said to be very low. Open end construction permits easy replacement of refill tape-rolls. The Target Punch-Reinforcer, product of Stationers Supply Corp., can be set up for only punching by shifting a small lever.

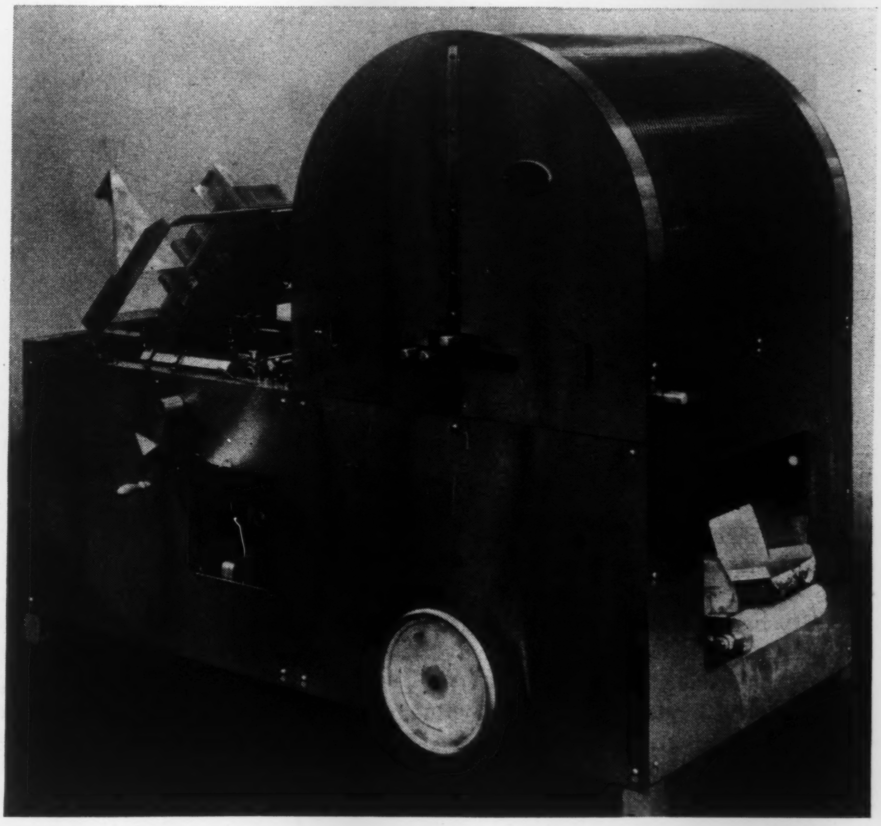
Unique Machine Makes Airfree Ice Cubes

COMPLETELY new and revolutionary in design, the ice cube maker shown right is capable of producing up to 5000 clear, solid cubes automatically in a 24 hr period. A continuous stream of water is circulated over a refrigerated freezer-plate so that a clear solid slab of ice builds up gradually on the flat inclined surface. When the layer of ice reaches a predetermined thickness, an automatic switch actuates the control to shut off the flow of water, and to circulate hot refrigerant gas through the freezer plate coil. After melting adjacent to the freezer plate, the slab of ice slides off the plate onto a grid of low-voltage electrically heated wires. Weight of the ice plus the small amount of heat in the wires virtually "cuts" the slab into solid cubes which drop into the storage bin below. The cabinet walls around the 100 lb storage bin are glass fiber insulated, to maintain storage temperature so that the cubes will neither melt nor stick together. The inside front of the bin pulls outward and downward to permit removal of the cubes. Styled by Raymond Loewy, the Frigidaire engineered unit utilizes a one-third horsepower Meter-Miser refrigerant compressor in conjunction with compactly arranged condenser, water circulating system and controls.



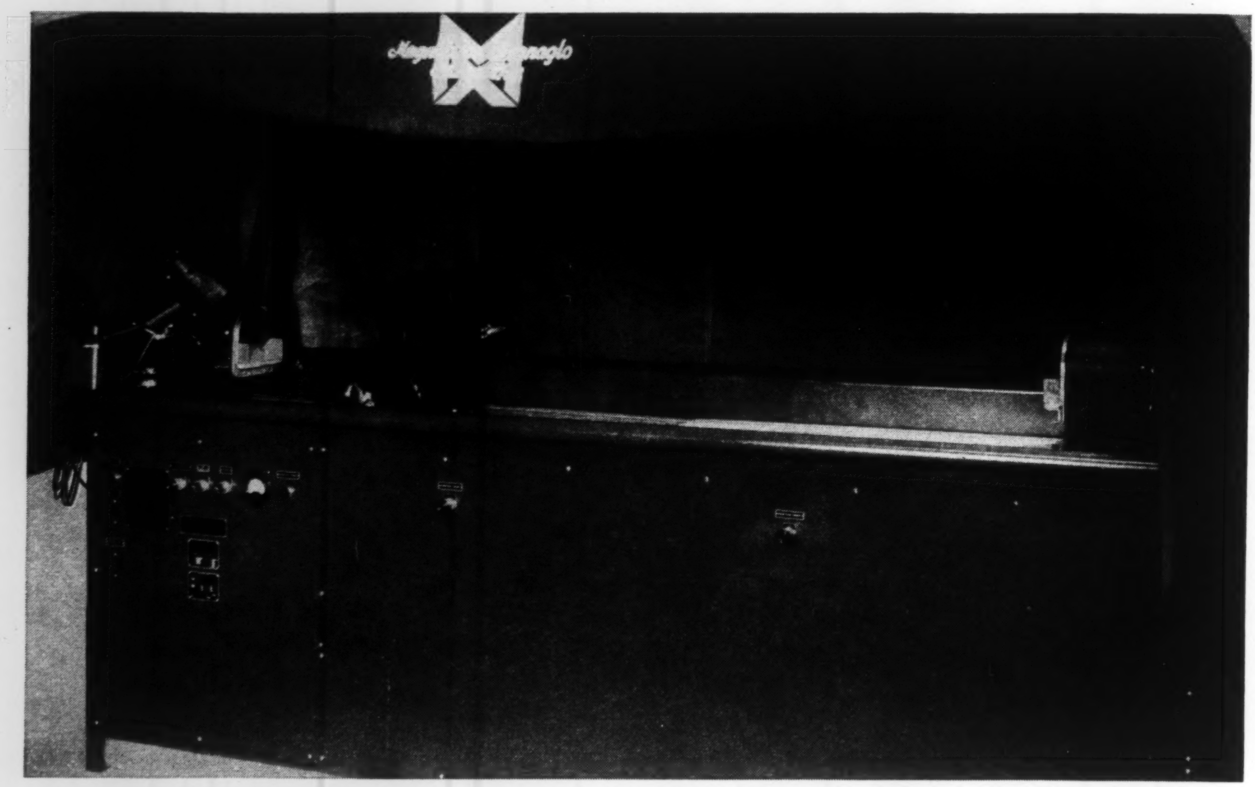
Former Produces Cartons Continuously

BY eliminating start-and-stop motions, the carton forming machine shown right achieves high production rates, being capable of folding and gluing up to 102 cartons per minute. Diecut blanks are fed automatically by a vacuum cupped arm



from a loading magazine positioned at convenient height while the formed cartons, properly oriented for filling, are discharged from an endless-belt conveyor at the opposite end of the machine. Designed for using either hot or cold adhesives, the glue-setting time in the machine is nine times greater than in other machines, despite the high production speed. Fine-thread screw adjustments to the foming plates make possible accurate registration of printed matter on the ends and sides of the cartons when folded over special forming mandrels. All side panels are arranged for easy removal to minimize changeover time as much as possible. Unlike previous machines, it is unnecessary to change the side pressure plates since they have been made fully adjustable within the size range of the machine. Self-aligning, semipermanently lubricated ball bearings of the sealed type are used at all critical points. Made by the Package Machinery Co., Palmer Division, the PA carton former occupies floor space 3 feet wide by 6 feet long. Since the only duties required of an attendant are to maintain blank and adhesive supply, one person can operate up to three machines simultaneously.

Redesign Improves Tester Delivery



COMPLETE redesign of all standard Magnaflux testing units has resulted in greatly improved delivery dates and in many instances reduced cost. Length capacity has been increased in most sizes and all units are now adapted for operation on either 220 or 440-volt, 60-cycle current.

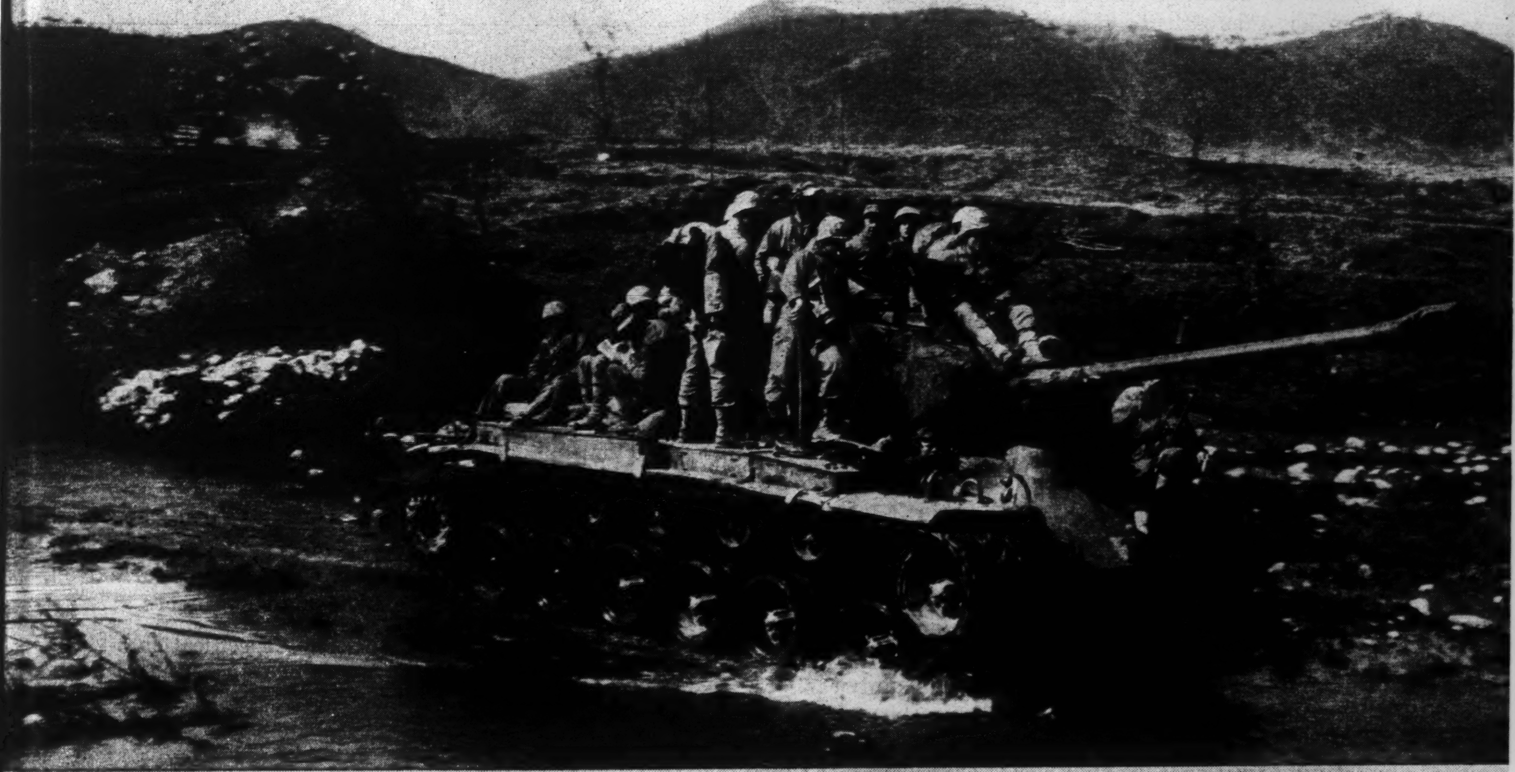
The unit illustrated above typifies the general changes in design. Instead of the fixed-type hood formerly furnished for Magnaglo inspection with infrared light, a new folding-type hood has been developed enabling heavy parts to be loaded with the aid of an overhead crane. For added operating convenience, all electrical controls have been relocated in the front panel of the machine. Some of the controls were previously located in a separate panel behind the worktable.

Their program of simplification and standardization is expected by the Magnaflux Corporation, to aid materially in the defense program by the increased production of test units made possible by redesign.

Protective Finishes

. . . phosphate coatings for military equipment

Part 2—Rustproofing and Protecting Friction Surfaces



By Norman P. Gentieu   American Chemical Paint Co.   Ambler, Pa.

Above—M-26 tank has rustproofing treatments on the exterior surfaces of the tank and machine gun. Working surfaces or friction parts of the tank and guns are treated with manganese-iron phosphate and rust-inhibiting oil

HEAVIER phosphate coatings such as Type II Classes A and B of U. S. Army specification 57-O-2C have been standard for a long time for rifles, machine guns, recoilless weapons, ammunition belt links and cartridge clips. Type II Class A Finish, typified by Thermoil-Granodine, is a manganese-base phosphate finish, while the Class B, typified by Permadine, is a zinc-base. Both are applied by immersion of precleaned work in "balanced" baths of appropriately catalyzed solutions of primary manganese and primary zinc phosphates, respectively. Coating weights and specification requirements for these finishes are shown in TABLE 3.

With proper attention paid to the precleaning method and final chromic-acid rinse procedures, these limits can be met with little difficulty. Dense, fine-grained coatings are the most desirable. They are obtained by a combination of factors, particularly in the precleaning. Abrasive cleaning such as sand-blasting is best but, in lieu of this, emulsion or alkaline cleaning may be used, preferably with subsequent wiping or sand tumbling of the parts. In this specific kind of finishing, freedom from "water-break" is less important than the rubbing action or so-called "wiping effect".

Where Government specifications do not prescribe the necessary after-treatment, it is recommended that the vendor's advice be followed. Granoleum and Granolac finishes are available, consisting of various rust-preventive oils, petrolatum cut-backs, wax solutions and lacquers, designed for various finished item requirements.

To compare the Type II Class A with Type II Class B finish, it should be stated that Class B has inherently greater corrosion resistance but somewhat lower wear resistance and heat resistance. Class A is preferred as a "wear-in" coating on reciprocating parts (bearing surfaces), particularly where high unit pressures are encountered. Typical civilian uses of Class A coatings are on cast-iron pistons, rocker arms, camshafts, crankshafts, lock nuts, gears and spiders. Military uses are small-arms weapons, recoilless guns, aircraft-engine hardware and artillery mechanisms.

Class B coatings are used on various hardware items as a substitute for cadmium or zinc plating. Military uses are for cartridge clips, links, mines, rifle barrels, automotive hardware and instrument parts. A relatively new use for Class B coatings is as a lubricant-retaining film for the deep-drawing and cold extrusion of steel. Manufacturers engaged in steel cartridge-case or shell manufacture would do well to consider this added insurance for the lubrication system.

Rustproofing

Rustproof coatings have many practical applications. During World Wars I and II, most small arms were rustproofed by phosphate coating and treating with chromic acid and a rust-preventive oil. Two objectives were thereby achieved: Excellent corrosion resistance was provided and a black matte nonreflecting surface was formed. Rustproof finishes are now used widely for fire-control instruments, steel aircraft parts, certain steel projectiles, bolt assemblies, hardware items, miscellaneous forgings and castings, tools, unpainted replacement machine parts, and many other similar items such as bolts, nuts and washers.

For the most effective rustproofing of large or small work in large or small production and for a finish meeting Army specification 57-O-2C for Type II Class B finish, the properly cleaned articles are immersed for not less than 30 minutes in a hot balanced phosphate rustproofing solution until a uniform crystalline phosphate coating is formed; after which the parts are immediately rinsed in clean water followed by a second rinse in a controlled dilute chromic-acid solution. After drying, a suitable corrosion-resistant oil is applied. Zinc-phosphate rustproof coatings when impregnated with suitable rust-preventive compounds have shown salt-spray resistance superior to many commercial cadmium or zinc-plated items.

Table 3—Coating Weight and Salt-Spray Resistance

Class	Coating Weight (mg/sq ft)	Salt-Spray Resistance Before Application (hr)	Salt-Spray Resistance After Application (hr)
A	1000-4000	1	24
B	1000-4000	2	36

Class B finishes are for use on nonmoving parts only and, even with the addition of a suitably reduced rust-preventive, are substantially dry to touch. According to specification requirements these finishes must withstand two hours of salt-spray exposure when unoiled; and 36 hours of salt spray exposure after treatment with a suitable oil. Army specification 57-O-2C, entitled *Finishes, Protective, For Iron and Steel Parts,* contains the following information, abstracted for reference by design engineers.

APPLICABLE SPECIFICATIONS: Army specification 3-181, *Enamel, Olive Drab, Rust-Inhibiting* forms a part of this specification.

USE: Type II Class B phosphate coatings, finished with a rust preventive suitably reduced for application on iron and steel and containing corrosion inhibitors, are for use on nonmoving parts only and shall be substantially dry to touch.

U. S. Army Photo

Gun and mount of 75-mm recoilless rifle are treated with manganese-iron phosphate and rust-inhibiting lubricating oil

U. S. Army Photo

A 105-mm howitzer motor carriage. Engine parts and wheel bolts of the tank have manganese-iron phosphate and oil treatment. The 50-caliber machine gun is protectively finished with zinc phosphate with the exception of the barrel which is phosphate and oil treated

Corrosion Resistance: Type II Class B finishes shall show no signs of corrosion when tested by salt spray for 2 hours before applying the specified finishing material and for 36 hours after applying the supplementary finish material.

Rustproof coatings are applied, naturally, after all metalworking operations, such as machining, brazing, welding, forming, perforating, etc., have been completed. The article is cleaned before coating, and the cleaning process should not attack the metal surface. This means that if an acid is used, the acid should contain an inhibitor. A standard rustproofing process should be used so that the coating which is produced will be an effective barrier against rust.

Rustproof coatings, unless otherwise specified, are impregnated with a thorough coating of a suitable rust-inhibiting compound, usually an oil. Excess oil is then removed by centrifuging, or draining. Oiled surfaces are employed where matte finishes with a moderate degree of corrosion resistance are required.

Military Specification MIL-C-16232 (BuOrd), entitled *Coatings—Phosphate; Oiled, Slushed Or Waxed (For Ferrous Metal Surfaces)* And *Phosphate Treating Compounds,* is a new specification for essentially the same type of rustproof coating, but gives greater detail. The Type II finish described in this specification is the same as the Type II Grade B finish discussed previously. The specification provides:

Scope: This specification covers the requirements for phosphate coatings applied to ferrous metal articles and the compounds used for producing them. The phosphate coatings covered by this specification are not intended as surface treatments prior to painting. Phosphate coatings shall be Type II for coatings on surfaces of nonmoving parts.

Coverage and Appearance: The phosphate coating shall be evenly deposited, have a uniformly crystalline texture, and be grey to black in color.

Thickness of Phosphate Coatings: Unless otherwise specified the thickness of Type II phosphate coatings per surface shall be 0.0002 to 0.0005-in. The coatings shall not prevent parts from meeting fit and clearance tolerances.

Workmanship: The workmanship shall be such as to insure that the phosphate coatings are adherent, homogeneous, uniform in appearance and free from injurious defects. Coatings shall be applied after all machining, welding, forming, perforating, and heat-treatment of the articles have been completed. Care must be exercised to prevent the entrapment of dirt, oil or chemicals as these may accelerate corrosion or prevent proper treatment of the metal surfaces.

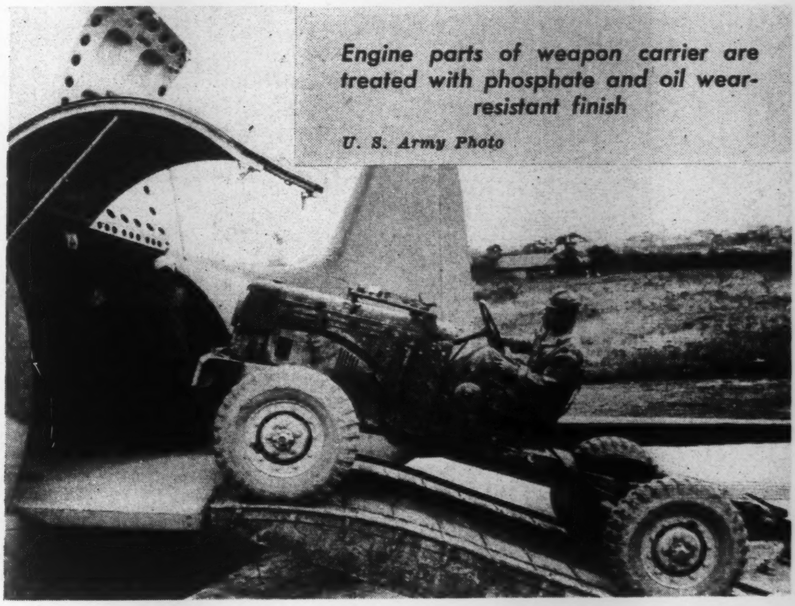
Use: Type II phosphate coating is for use where a matte finish with somewhat more corrosion resistance than Type I is required.

Steel: A contributing effect results from the chemical composition of the steel from which the parts to be coated are manufactured and the parts may be further affected by various material and treatment factors such as:

1. Hardness and finish (surface roughness)
2. Surface preparation and metal cleaning (strong alkali pickling should be avoided)
3. Bath composition (total acid to free acid ratio and iron content)
4. Time of immersion
5. Bath temperature.

When properly prepared and rinsed, and bearing suitable protective oils, waxes, etc., the rustproof coating will withstand considerably more than the specified salt-spray hours. Occasionally, the coating is relied on for corrosion resistance unprotected by oil or wax. Such special cases represent deviations from the established specifications. Phosphate coatings which are used primarily to impart corrosion-resistance to steel should be given a final rinse in a solution of extremely dilute CP chromic acid or phosphoric acid. This will assure maximum corrosion resistance.

Thickness specified for phosphate coatings does not represent a dimension added to the original dimension of the metal. It should be remembered that some of



Engine parts of weapon carrier are treated with phosphate and oil wear-resistant finish

U. S. Army Photo

the steel surface is dissolved in this coating process. The overall dimensional change is practically negligible. A reliable picture of the phosphate coating phenomenon can be derived from a weight measurement. For rustproofing, the coating weight range is usually from 1000 to 4000 milligrams per square foot. This is also the weight range for wearproof finishes such as Thermoil-Granodine or Parko Lubrite.

Protection for Friction Surfaces

Fabricators and designers, particularly in the automotive field, are aware that even highly polished surfaces under friction will weld, gall and score. One of the most inexpensive and practical methods of preventing destructive actions is to coat the metal, preventing metal-to-metal contact. With cast iron or steel, the manganese-iron phosphate type of conversion coating provides a wear-resistant layer of unusual effectiveness. It is normally used on friction surfaces such as pistons, piston rings, rocker arms, camshafts, levers, valve tappets, cylinder liners and spiders for universal joints.

Manganese-iron phosphate crystals are relatively soft. When two phosphate-coated parts rub together, the crystals are crushed in the process. Acting with the lubricating oil, they serve as a cushion, preventing metal-to-metal contact. The unique properties of the manganese-iron phosphate coating which enable it to protect the underlying metal so effectively are both chemical and mechanical. By preventing metal-to-metal contact, the coating removes the danger of welding. In addition, the coating deforms under pressure, thus reducing maximum stresses. The mild abrasive properties of the manganese-iron phosphate coating assist in lapping or wearing-in the parts which are rubbing together. This effect is enhanced by the adsorption of a lubricating oil by the manganese-iron phosphate crystals. Finally, the etching action of the coating solution produces a porous surface under the coating which improves the wearing qualities and leaves minute oil reservoirs when all traces of the coating have disappeared.

Formerly, tin plating of friction surfaces was employed to facilitate wearing-in of parts. However, because of the strategic nature of tin and the high cost of tin plating, the phosphate finish has replaced it in many instances, often with improved performance. The manganese-iron phosphate film is superior to tin in its ability to adsorb and hold oil. Also, it is accompanied by an etch pattern in the basis metal which is ideal for bearing surfaces.

Manganese-iron phosphate coatings meet Type II Class A requirements of Army specification 57-O-2C and equivalent requirements of other specifications. These coatings are impregnated with nondrying petroleum oils containing corrosion inhibitors and are suitable for use on sliding, rubbing or bearing surfaces. They are used where a nongalling finish is desired. According to specification requirements these finishes must withstand one hour of salt-spray exposure when unoiled; and 24 hours salt spray exposure when treated with a suitable oil. Class A finishes are now specified for small arms, machine-gun parts, automotive and aircraft-engine components such as pistons, piston rings, cylinders, cylinder liners, cranks, camshafts, gears tappets, valves, spiders, and tank treads.

Manganese-iron phosphate coating and rust-inhibiting oil treatment is applied to the gun mount as well as elevating and traverse mechanisms

U. S. Army Photo

The process involves several different operations, but essentially it consists of: Cleaning and rinsing; removing rust or residual scale, if present, and rinsing; phosphate coating and rinsing, including a final acidulated rinse.

Army specification 57-O-2C provides for Type II Class A phosphate coatings finished with nondrying petroleum oils containing corrosion inhibitors and suitable for use on sliding or bearing surfaces of iron and steel:

WORKMANSHIP: The iron or steel shall be subjected to such polishing, cleaning, pickling, and coating procedures as are necessary to insure deposits with the desired appearance and quality. The cleaning process prior to finishing shall be performed with minimum abrasion, erosion or pitting of the surface. Coatings shall be applied after all machining, brazing, welding, forming and perforating on the article have been completed.

CORROSION: Type II Class A finishes shall show no signs of corrosion when tested by salt spray for 1 hour before applying the specified finishing material nor for 24 hours after applying the supplementary finishing material.

Military specification MIL-C-16232 (BuOrd) also covers phosphate coatings on bearing surfaces. Requirements abstracted from this specification are:

SUPPLEMENTARY FINISH: After cooling, phosphate-coated parts shall be impregnated with oil, conforming to MIL-L-3150, after which the parts shall be either centrifuged or permitted to drain.

COVERAGE AND APPEARANCE: The phosphate coating shall be evenly deposited, have a uniformly crystalline texture, and be grey to black in color.

THICKNESS OF PHOSPHATE COATINGS: Unless otherwise specified the thickness of Type I phosphate coatings per surface shall be 0.0002 to 0.0004-inch. The coatings shall not cause failure of parts to meet drawing dimensions that are applicable to fit and clearance tolerances.

USE: Type I phosphate coating is for use on moving or bearing surfaces where a matte finish with a moderate degree of corrosion resistance is required to prevent wear and assist in "break in" of bearing surfaces.

Finishes for protecting friction surfaces are usually manganese-iron phosphate coatings impregnated with nondrying petroleum oils containing corrosion inhibitors. For friction surfaces, for surfaces which may reach moderately elevated temperatures in service, or for surfaces subjected to the actions of alkaline environment, manganese-iron phosphate coatings are preferred to zinc-phosphate. The object of the manganese-iron phosphate finish is two fold: Protection of friction or bearing surfaces and rust prevention. The weight of this type phosphate coating ranges from 1000 to 4000 milligrams per square foot.

Conclusion

Chemical conversion coatings—especially phosphate coatings—play an important role in the protective finishing drama, serving as a foundation for more decorative films, protecting metal from rust and corrosion, or wearing on a friction surface to break-in a moving part safely. Since the metals that are normally industry's first choice—steel, copper, aluminum, zinc, cadmium, nickel and chromium—are in short supply, the protection that phosphate coatings afford assumes ever increasing importance.

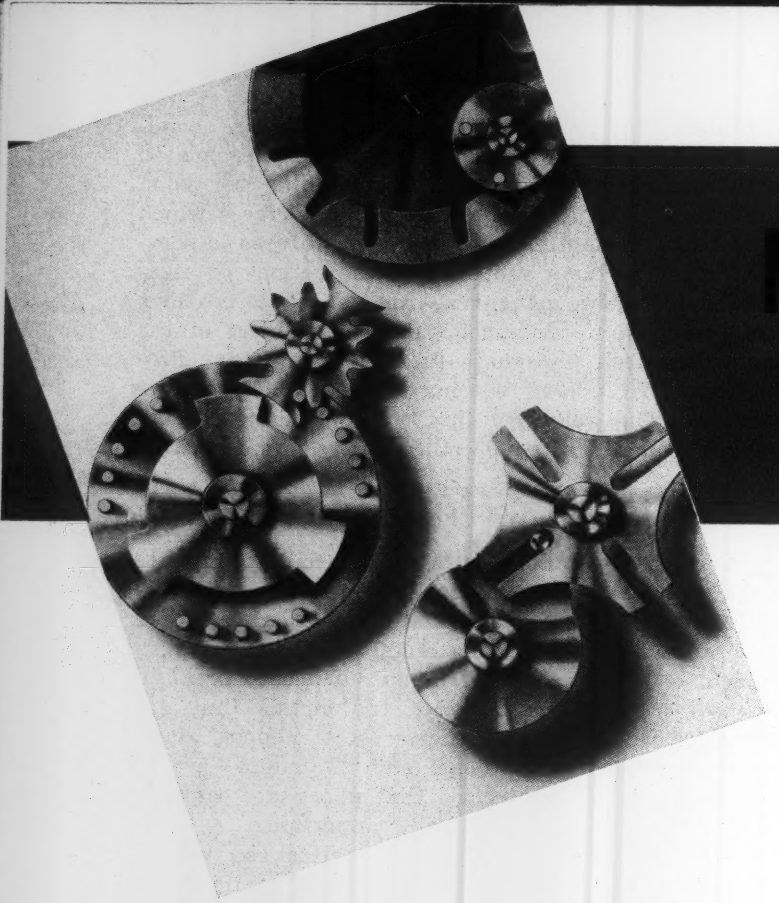
Both civilian and military production can benefit from the increased use of phosphate coatings for metal preservation and paint protection. From fancy, decorative copper-nickel-chromium automotive and appliance finishes, for example, the design engineer may have to shift to zinc plating with chromate treatments, or phosphate coatings plus rust-preventive compounds for the protection of steel as called for by U. S. Army Specification 57-O-2C. On military items of aluminum, most of which were formerly anodized (Air Force-Navy Aeronautical Specification AN-QQ-A-696a), fabricators can now use the simpler, less expensive and often more effective chemical conversion coatings (Military Specification MIL-C-5541).

The age-old conflict between process specifications and performance specifications is being resolved in favor of the latter. It is finally being realized that it is impossible to tell a manufacturer exactly what

(*Concluded on Page* 222)

Amphibious truck. Friction-surface finish of manganese-iron phosphate and oil is used on engine parts and tire bolts

U. S. Army Photo



MECHANISMS FOR

By Otto Lichtwitz
Mechanical Engineer
London, England

INTERNAL Geneva mechanisms have proved useful in fields other than those covered by the external Geneva mechanisms (Part 1, December, 1951, MACHINE DESIGN). Star wheels can likewise be laid out for internal drives.

Internal Star Wheel Mechanisms: These mechanisms do not lead to results beyond those obtainable by external star wheel mechanisms (Part 2, January issue). Although internal Geneva mechanisms are advantageous with regard to kinematic properties, internal star wheel mechanisms are superior only if the driven gear lies inside the driving gear. However, internal star wheel mechanisms are often simpler to design and to manufacture than external mechanisms, because the accelerating and retarding rollers are frequently sufficient for imparting the uniform motion. Internal star wheel mechanisms have the common feature with other internal gears that both gears rotate in the same direction, and they provide a compact unit, particularly if the center distance is limited.

As with internal Geneva mechanisms, negative values of μ can also be substituted in the equations for external mechanisms, but some of the negative results are likely to be misinterpreted or to be wrongly applied.

Distinction must be made between mechanisms with values of μ larger and smaller than 1, that is with driven gears larger and smaller than the driving gears. In the former case, the driving gear lies inside the driven gear, *Figs*. 33 and 34; in the latter case, it is vice versa, *Figs*. 35 and 36. It will later be found that both groups of internal star wheel mechanisms are separated by an interval on both sides of the value of $\mu = 1$. This condition is analogous to common internal gears for which ratios in the neighborhood of unity are not feasible because of interference of teeth not supposed to be meshing.

To simplify the understanding, the two groups of internal star wheel mechanisms will be treated separately.

GEOMETRY: In *Fig*. 37*a* is shown an internal star wheel mechanism, with $\mu < 1$, in the position where the driven gear commences its motion. The center line *CD* of the accelerating slot is a part of a pericycloid, which is generated by a point on the pitch circle 1 as it rolls, without sliding, along the pitch circle 2 with the centers of both circles lying on the same side of the point of contact. For reasons already known, the pericycloid must have at the point *D* a common tangent with the circle 1.

The same references as used in *Fig*. 21*a* (Part 2) make the many analogies with external mechanisms obvious, and justify only a brief derivation of the equations.

In the isosceles triangle *ABF, Fig*. 37*a,* the distance $AB = r_1 - r_2$, and $BF = r_2$, so that

$$\sin \frac{\alpha_0}{2} = \frac{\mu}{2(1-\mu)} \quad \ldots\ldots\ldots\ldots\ldots\ldots (20a)$$

$$\alpha_0 = 2 \sin^{-1} \frac{\mu}{2(1-\mu)} \quad \ldots\ldots\ldots\ldots\ldots\ldots (21a)$$

The angle *HBF* is $\alpha_0/2$, and the angle *FBE* is α_0, so that the angle *C′BE* is equal to $\frac{1}{2}\pi + 1\frac{1}{2}\alpha_0$; the angle ϕ_0, which determines the point *D,* is

$$\phi_0 = \frac{\pi}{4} + \frac{3\alpha_0}{4} = \frac{\pi}{4} + \frac{3}{2} \sin^{-1} \frac{\mu}{2(1-\mu)} \quad (22a)$$

The arcs *CE* and *DE* are equal to $r_1\alpha_0$; the angle $CBE = r_1\alpha_0/r_2 = \alpha_0/\mu$, and *Fig*. 37*a* reveals that

$$\beta_0 = \frac{\pi}{2} + \frac{3\alpha_0}{2} - \frac{\alpha_0}{\mu} = \frac{\pi}{2} - \frac{\alpha_0}{2}\left(\frac{2-3\mu}{\mu}\right)$$
$$= \frac{\pi}{2} - \left(\frac{2-3\mu}{\mu}\right) \sin^{-1} \frac{\mu}{2(1-\mu)} \quad \ldots\ldots (23a)$$

ERMITTENT MOTION

PART 3

With the center distance *a*, the radii of driving and driven gears are

$$r_1 = \frac{a}{1-\mu} \quad \ldots\ldots (24a)$$

$$r_2 = \frac{a\,\mu}{1-\mu} \quad \ldots\ldots (25a)$$

The distance $s = C'D$ is

$$s = \frac{a\,\mu}{(1-\mu)^2} \quad \ldots\ldots (26a)$$

and can be obtained graphically by scribing a circle with center at *A*, and radius equal to the center distance *AB*, as far as the intersection *F* with the pitch circle of the driven gear; the produced straight line *AF* intersects the pitch circle of the driving gear at the required point *D*.

The angle $BC'D = \frac{1}{2}\pi - \frac{1}{2}\alpha_0$, the angle $C'BD = \phi_0 = \frac{1}{4}\pi + \frac{3}{4}\alpha_0$, and the angle $C'DB = \pi - (\frac{1}{2}\pi - \frac{1}{2}\alpha_0) - (\frac{1}{4}\pi + \frac{3}{4}\alpha_0) = \frac{1}{4}\pi - \frac{1}{4}\alpha_0$.

With the sine rule, $\rho_0/r_2 = \sin(\frac{1}{2}\pi - \frac{1}{2}\alpha_0)/\sin(\frac{1}{4}\pi - \frac{1}{4}\alpha_0) = 2\cos(\frac{1}{4} - \frac{1}{4}\alpha_0)$, and it follows that $\rho_0 = 2\,r_2 \cos(\frac{1}{4}\pi - \frac{1}{4}\alpha_0)$, or that

$$\rho_0 = 2\,a\,\frac{\mu}{1-\mu}\cos\left(\frac{\pi}{4} - \frac{\alpha_0}{4}\right) \quad \ldots\ldots (27a)$$

As with external star wheel mechanisms, the ratio of the angles of the driving and driven gears is

$$\varepsilon = \frac{2\,\alpha_0 + \mu\left(\dfrac{2\pi}{n} - 2\,\beta_0\right)}{\dfrac{2\,\pi}{n}}$$

and with Equations 21*a* and 23*a* it is found that

$$\varepsilon = \mu + n\,\frac{4-3\,\mu}{\pi}\sin^{-1}\frac{\mu}{2(1-\mu)} - \frac{n\,\mu}{2} \quad \ldots\ldots (28a)$$

For $n = 1$,

$$\varepsilon_1 = \frac{\mu}{2} + \frac{4-3\,\mu}{\pi}\sin^{-1}\frac{\mu}{2(1-\mu)} \quad \ldots\ldots (29a)$$

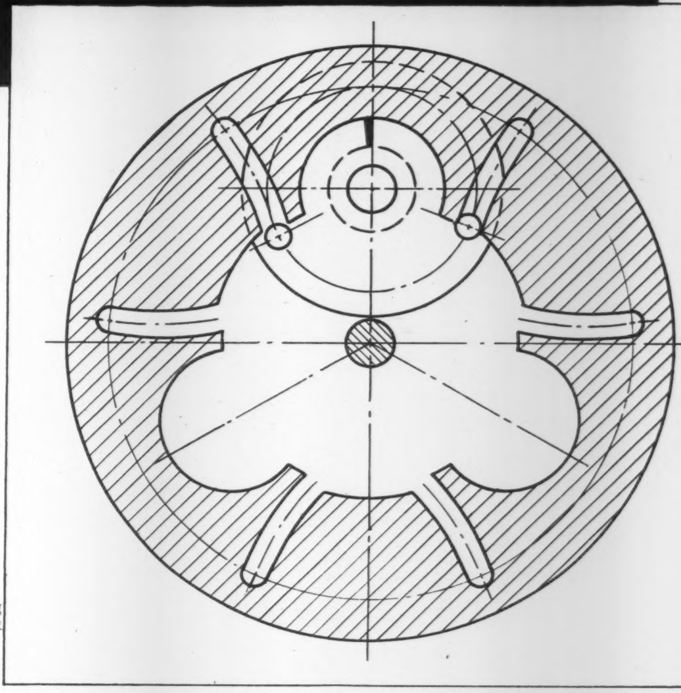


Fig. 33—Internal star wheel mechanism, $n=3$, $\mu=2.5$, $\epsilon=2.9575$

The maximum of ϵ is, as with external drives,

$$\varepsilon_{max} = n \quad \ldots\ldots (30a)$$

and the value of μ which pertains to the maximum of ϵ must comply with the condition

$$\frac{4-3\,\mu_{max}}{\pi\,\mu_{max}}\sin^{-1}\frac{\mu_{max}}{2(1-\mu_{max})} - \frac{1}{\mu_{max}} = \frac{n-2}{2\,n} \quad \ldots\ldots (31a)$$

The minimum of ϵ is, as with external drives,

$$\varepsilon_{min} = \frac{3\,n}{2\,\pi}\,\alpha_0 = \frac{3\,n}{\pi}\sin^{-1}\frac{\mu}{2(1-\mu)} \quad \ldots\ldots (32a)$$

and the value of μ which pertains to ϵ_{min} must comply with the condition

$$\frac{1-3\,\mu_{min}}{\mu_{min}}\sin^{-1}\frac{\mu_{min}}{2(1-\mu_{min})} = \frac{\pi}{2}\,\frac{n-2}{n} \quad \ldots\ldots (33a)$$

The maximum of the left-hand side of Equation 33*a* pertains to $\mu = 0$, and amounts to $\frac{1}{2}$. The corresponding $n = 2\pi/(\pi-1) = 2.93$, which has already been met with in external star wheel mechanisms.

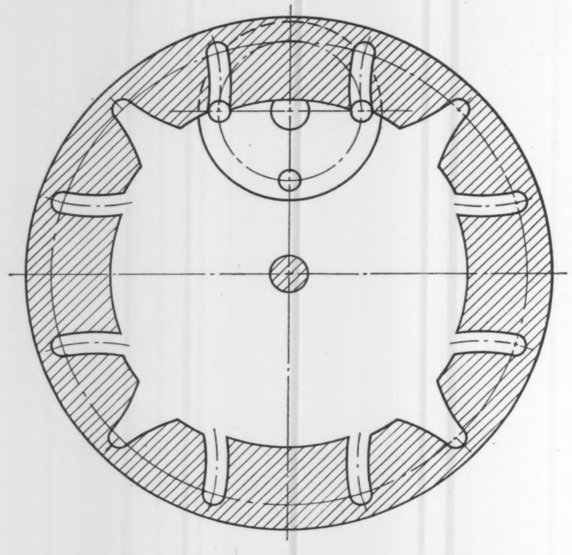


Fig. 34—Above — Internal star wheel mechanism, $n=4$, $\mu=3.4142$, $\epsilon=\epsilon_{max}=4$

Fig. 35—Below — Internal star wheel mechanism, $n=2$, $\mu=0.3420$, $\epsilon=0.5$

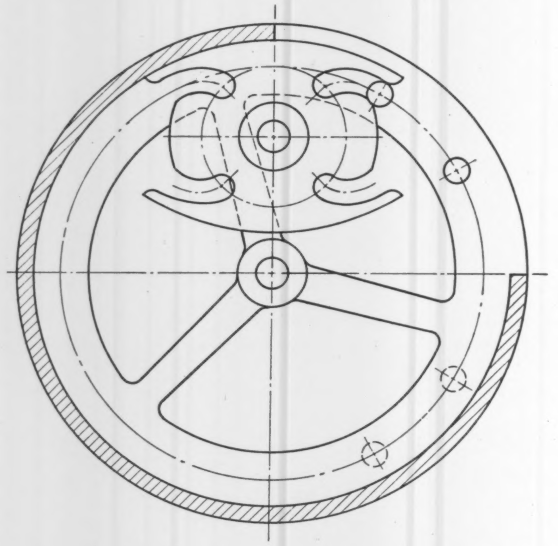
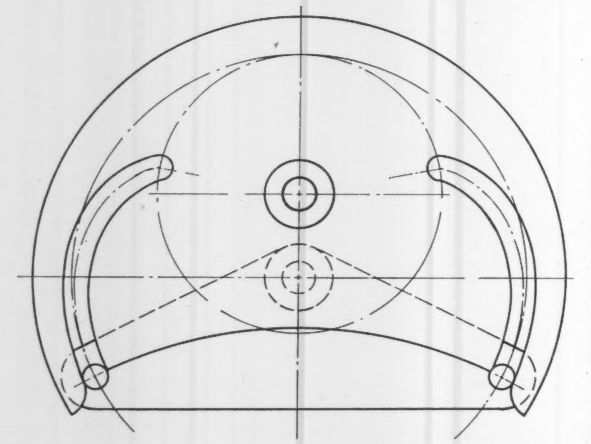


Fig. 36 — Below — Internal star wheel mechanism, $n=1$, $\mu=0.6302$, $\epsilon=\epsilon_{max}=1$



Since the right-hand side of Equation 33*a* is increasing with increasing n, it follows that n cannot exceed 2.93; n can consequently be only 1 or 2, and μ can be kept as small as desired. In the extreme cases, with $\mu = 0$, the mechanisms are identical with those shown in *Figs.* 22 and 23 (Part 2).

Table 7—Extreme Values for Internal Star Wheel Mechanisms

n Stations	ε_{max} Eq. 30*a,b*	μ_{max} Eq. 31*a,b*	ε_{min} Eq. 32*a,b*	μ_{min} Eq. 33*a,b*	m_{max} Eq. 49*a,b*
1	1	0.6302	0	0	∞
2	2	0.6340	0	0	∞
3	3	2.5420	2.8955	2.4399	1
4	4	3.4142	3.4056	2.7980	1
5	5	4.3011	3.9112	3.1676	1
6	6	5.1882	4.4154	3.5434	1
7	7	6.0748	4.9179	3.9219	1
8	8	6.9620	5.4201	4.3011	1
9	9	7.8479	5.9214	4.6830	1
10	10	8.7330	6.4227	5.0643	1

Although the previous considerations are analogous to those for external mechanisms, a difference is due to the circumstance that $1 + \mu$ is replaced by $1 - \mu$. The value of $\sin \alpha_0/2 = \mu/2(1-\mu)$ could, with increasing value of μ, become impossible, and a limit is drawn by $\mu/2(1-\mu)<1$, or $\mu<\frac{2}{3}=0.6667$.

Another limiting factor is that the driving gear must rotate at least through an angle $3\alpha_0$, for the same reason as with external star wheel mechanisms. Consequently, $\frac{1}{2}\alpha_0$ cannot exceed $360/6 = 60$ deg, and $\mu/2(1-\mu)<\sin 60° = \frac{1}{2}\sqrt{3}$, or

$$\mu < \frac{3-\sqrt{3}}{2} = 0.6340 \quad \ldots\ldots \quad (53a)$$

The latter limit is governing as it is lower than the former. In TABLE 7, which contains the extreme values of ϵ and μ, the maximum of μ for $n = 1$ is determined by Equation 31, and the maximum for $n = 2$ by Equation 53*a*.

If the value of ϵ is specified, μ must be evaluated by means of Equation 28*a*. TABLE 8 obviates, in most cases, solving the transcendent equations. Here again, it is advisable not to cling too closely to an evaluated odd value of μ, but rather to proceed as in Example 5.

The duration of motion, expressed in parts of one revolution of the driving gear, is the same as for external star wheel mechanisms, namely

$$\nu = \frac{\varepsilon}{n} \quad \ldots\ldots \quad (35a)$$

and for $n = 1$,

$$\nu_1 = \varepsilon \quad \ldots\ldots \quad (36a)$$

Also,

$$\nu_{max} = \frac{\varepsilon_{max}}{n} \quad \ldots\ldots \quad (37a)$$

$$\nu_{min} = \frac{\varepsilon_{min}}{n} = 0 \quad \ldots\ldots \quad (38a)$$

The angle γ over which the locking drum extends is, as for external drives,

$$\gamma = 2\left\lfloor \pi\left(1-\frac{\mu}{n}\right) - \alpha_0 + \mu\beta_0 \right\rfloor \qquad (39a)$$

and in the case of $n = 1$,

$$\gamma_1 = 2[\pi(1-\mu) - \alpha_0 + \mu\beta_0] \qquad (40a)$$

Design data α_0, β_0, ϕ_0, r_1, r_2, s, and ρ_0 are contained in TABLE 9 in small steps of μ.

EXAMPLE 10: Design an internal star wheel mechanism which imparts, during 90 deg of the driving gear, half a revolution to the driven gear (*Fig.* 35). Center distance $a = 5$ inches.

The ratio $\epsilon = 90$ deg/180 deg $= 0.5$ and TABLE 8 indicates, for $n = 2$, the value $\mu = 0.3420$. That value may be replaced by $\mu = 13/38 = 0.342105$, in order to obtain rational dimensions of the pitch diameters.

From Equation 20*a*, $\sin \alpha_0/2 = (13/38)/2(25/38) = 0.26$. Then $\alpha_0/2 = 15$ deg 4 min $= 15.067$ deg or $\alpha_0 = 30$ deg 8 min.

From Equation 22*a*, $\phi_0 = 45$ deg $+ \frac{3}{4}\alpha_0 = 45$ deg $+ 22$ deg 36 min $= 67$ deg 36 min.

From Equation 23*a*, $\beta_0 = 90$ deg $- (37/13)\ 15.067$ deg $= 90$ deg $- 42.883$ deg $= 47.117$ deg $= 47$ deg 7 min.

From Equation 24*a*, $r_1 = 5/[1-(13/38)] = 7.6$ inches.

From Equation 25*a*, $r_2 = [5(38/25)]\ 13/38 = 2.6$ inches.

From Equation 26*a*, $s = [5(13/38)]/(25/38)^2 = 3.952$ inches.

From Equation 27*a*, $\rho_0 = 2(5)(13/25) \cos 37$ deg 28 min $= 4.127$ inches.

All these values can be interpolated from those in TABLE 9.

From Equation 28*a*, $\epsilon = (13/38) + 2[4-(39/38)] \times (15.067/180) - (13/38) = 0.49783$. This value differs slightly from the intended value 0.5, and means that the motion occupies 89 deg 37 min instead of 90 deg.

From Equation 35*a*, $\nu = 0.49783/2 = 0.248915$, which again differs only slightly from the intended 0.25.

From Equation 39*a*,

$$\gamma = 2\left[180\left(1-\frac{13}{2(38)}\right) - (2)(15.067) + \frac{13}{38}(47.117)\right]$$

$$= 270.392 \text{ deg} = 270 \text{ deg } 23 \text{ min}$$

which can be made 270 deg as originally intended.

It is interesting to carry out the calculations for $\epsilon = \frac{2}{3}$ and $n = 1$, or $\epsilon = 5/6$ and $n = 2$. In these cases, μ assumes the round value of 0.5, and all angles and almost all other dimensions appear as round figures.

In the case of $\epsilon = \epsilon_{max}$, there is no locking drum because the driven gear is periodically retarded to zero velocity without remaining at rest. A gear of that

Table 8—Relation Between Basic Properties for Internal Star Wheel Mechanisms

	μ									
ϵ	$n=1$	$n=2$	$n=3$	$n=4$	$n=5$	$n=6$	$n=7$	$n=8$	$n=9$	$n=10$
1/8=0.12500	0.10810	0.09518	.....	.....	.....	.....	.....	.....	.....	.....
1/7=0.14286	0.12320	0.10833	.....	.....	.....	.....	.....	.....	.....	.....
1/6=0.16667	0.14318	0.12567	.....	.....	.....	.....	.....	.....	.....	.....
1/5=0.2000	0.17085	0.14958	.....	.....	.....	.....	.....	.....	.....	.....
1/4=0.2500	0.2116	0.18459	.....	.....	.....	.....	.....	.....	.....	.....
1/3=0.3333	0.2773	0.2405	.....	.....	.....	.....	.....	.....	.....	.....
3/8=0.3750	0.3089	0.2672	.....	.....	.....	.....	.....	.....	.....	.....
2/5=0.4000	0.3275	0.2828	.....	.....	.....	.....	.....	.....	.....	.....
1/2=0.5000	0.3980	0.3420	.....	.....	.....	.....	.....	.....	.....	.....
3/5=0.6000	0.4618	0.3957	.....	.....	.....	.....	.....	.....	.....	.....
5/8=0.6250	0.4766	0.4082	.....	.....	.....	.....	.....	.....	.....	.....
2/3=0.6667	0.5000	0.4283	.....	.....	.....	.....	.....	.....	.....	.....
3/4=0.7500	0.5422	0.4654	.....	.....	.....	.....	.....	.....	.....	.....
4/5=0.8000	0.5646	0.4858	.....	.....	.....	.....	.....	.....	.....	.....
5/6=0.8333	0.5781	0.5000	.....	.....	.....	.....	.....	.....	.....	.....
1=1.0000	0.6302	0.5534	.....	.....	.....	.....	.....	.....	.....	.....
3=3.0000	.....	.....	2.5420	.....	.....	.....	.....	.....	.....	.....
3-1/2=3.5000	.....	.....	.....	2.8953	.....	.....	.....	.....	.....	.....
4=4.0000	.....	.....	.....	3.4142	3.2609	.....	.....	.....	.....	.....
4-1/2=4.5000	.....	.....	.....	.....	3.7832	3.6329	.....	.....	.....	.....
5=5.0000	.....	.....	.....	.....	4.3011	4.1558	4.0082	.....	.....	.....
6=6.0000	.....	.....	.....	.....	.....	5.1882	5.0491	4.9080	4.7652	.....
7=7.0000	.....	.....	.....	.....	.....	.....	6.0748	5.9398	5.8042	5.6664
8=8.0000	.....	.....	.....	.....	.....	.....	.....	6.9620	6.8291	6.6957
9=9.0000	.....	.....	.....	.....	.....	.....	.....	.....	7.8479	7.7168
10=10.0000	.....	.....	.....	.....	.....	.....	.....	.....	.....	8.7330

Table 9—Properties of Internal Star Wheel Mechan

μ	α_0	ϕ_0	β_0	$\frac{r_1}{a}$	$\frac{r_2}{a}$	$\frac{s}{a}$	$\frac{\rho_0}{a}$	ε	ν	γ	n for ε, ν &
	Eq. 21*a*	**Eq. 22*a***	**Eq. 23*a***	**Eq. 24*a***	**Eq. 25*a***	**Eq. 26*a***	**Eq. 27*a***	**Eq. 28*a***	**Eq. 35*a***	**Eq. 39*a***	
0.00	0°	45°	32°42′	1	0	0	0	0	0	360°	1
0.02	1°10′	45°52′	33°17′	1.0204	0.02041	0.02082	0.02901	0.02280	0.02280	351°48′	1
0.04	2°23′	46°47′	33°53′	1.0417	0.04167	0.04340	0.05953	0.04573	0.04573	343°32′	1
0.06	3°39′	47°44′	34°31′	1.0638	0.06383	0.06790	0.09170	0.06881	0.06881	335°14′	1
0.08	4°59′	48°44′	35°11′	1.0870	0.08696	0.09452	0.12563	0.09205	0.09205	326°52′	1
0.10	6°22′	49°47′	35°52′	1.1111	0.11111	0.12346	0.16147	0.11546	0.11546	318°26′	1
0.12	7°49′	50°52′	36°34′	1.1364	0.13636	0.15496	0.19933	0.13906	0.13906	309°56′	1
0.14	9°20′	52° 0′	37°19′	1.1628	0.16279	0.18929	0.2394	0.16286	0.16286	301°22′	1
0.16	10°55′	53°12′	38° 5′	1.1905	0.19048	0.2268	0.2819	0.18687	0.18687	292°44′	1
0.18	12°36′	54°27′	38°53′	1.2120	0.2120	0.2677	0.3270	0.2110	0.2110	284° 0′	1
0.20	14°22′	55°46′	39°44′	1.2500	0.2500	0.3125	0.3749	0.2356	0.2356	275°10′	1
0.22	16°13′	57°10′	40°37′	1.2821	0.2821	0.3616	0.4260	0.2604	0.2604	266°15′	1
0.24	18°10′	58°38′	41°33′	1.3158	0.3158	0.4155	0.4806	0.2856	0.2856	257°12′	1
0.26	20°14′	60°11′	42°32′	1.3514	0.3514	0.4748	0.5389	0.3110	0.3110	248° 2′	1
0.28	22°25′	61°49′	43°33′	1.3889	0.3889	0.5401	0.6011	0.3368	0.3368	238°44′	1
0.30	24°45′	63°34′	44°38′	1.4286	0.4286	0.6122	0.6678	0.3631	0.3631	229°17′	1
0.32	27°13′	65°25′	45°46′	1.4706	0.4706	0.6920	0.7396	0.3898	0.3898	219°40′	1
0.34	29°51′	67°24′	46°59′	1.5152	0.5152	0.7806	0.8171	0.4171	0.4171	209°50′	1
0.36	32°40′	69°30′	48°16′	1.5625	0.5625	0.8789	0.9006	0.4450	0.4450	199°48′	1
0.38	35°41′	71°46′	49°37′	1.6129	0.6129	0.9886	0.9908	0.4736	0.4736	189°31′	1
0.40	38°56′	74°12′	51° 3′	1.6667	0.6667	1.1111	1.0887	0.5029	0.5029	178°58′	1
0.42	42°27′	76°50′	52°36′	1.7241	0.7241	1.2485	1.1953	0.5331	0.5331	168° 4′	1
0.44	46°16′	79°42′	54°15′	1.7857	0.7857	1.4030	1.3115	0.5644	0.5644	156°49′	1
0.46	50°25′	82°49′	56° 1′	1.8519	0.8519	1.5775	1,4385	0.5969	0.5969	145° 6′	1
0.48	54°58′	86°14′	57°56′	1.9231	0.9231	1.7752	1.5785	0.6309	0.6309	132°52′	1
0.50	60° 0′	90° 0′	60° 0′	2.0000	1.0000	2.0000	1 7321	0.6667	0.6667	120° 0′	1
0.52	65°36′	94°12′	62°15′	2.0833	1.0833	2.2570	1.9018	0.7046	0.7046	106°21′	1
0.54	71°53′	98°54′	64°42′	2.1739	1.1739	2.5519	2.0910	0.7452	0.7452	91°43′	1
0.56	79° 3′	104°17′	67°25′	2.2727	1.2727	2.8926	2.3021	0.7894	0.7894	75°49′	1
0.58	87°20′	110°30′	70°25′	2.3810	1.3810	3.2880	2.5392	0.8383	0.8383	58°13′	1
0.60	97°11′	117°53′	73°48′	2.5000	1.5000	3.750	2.8057	0.8939	0.8939	38°12′	1
0.62	109°20′	127° 0′	77°39′	2.6316	1.6316	4.2937	3.0955	0.9599	0.9599	14°26′	1
0.634	120° 0′	135° 0′	80°43′	2.7321	1.7321	4.7321	3.3464	1.0817	0.5409	228°14′	2
	Eq. 21*b*	**Eq. 22*b***	**Eq. 23*b***	**Eq. 24*b***	**Eq. 25*b***	**Eq. 26*b***	**Eq. 27*b***	**Eq. 28*b***	**Eq. 35*b***	**Eq. 39*b***	
2.44	115°49′	41°52′	36°16′	0.6944	1.6944	1.1767	0.9370	2.8956	0.9652	16°15′	3
2.6	108°41′	36°31′	31°13′	0.6250	1.6250	1.0156	0.9951	.....	.....	.....	..
2.8	102° 7′	31°35′	26°42′	0.5556	1.5556	0.8642	1.0371	3.4077	0.8519	53°19′	4
3.0	97°11′	27°33′	23°23′	0.5000	1.5000	0.7500	1.0606	3.6019	0.9005	35°56′	4
3.2	93°19′	24°59′	20°49′	0.4545	1.4545	0.6612	1.0742	3.7941	0.9485	18°34′	4
3.4	90°12′	22°39′	18°46′	0.4167	1.4167	0.5903	1.0820	3.9863	0.9966	1°14′	4
3.6	87°38′	20°43′	17° 6′	0.3846	1.3846	0.5326	1.0862	4.3242	0.8648	48°40′	5
3.8	85°28′	19° 6′	15°42′	0.3571	1.3571	0.4847	1.0881	4.5162	0.9032	34°50′	5
4.0	83°37′	17°43′	14°32′	0.3333	1.3333	0.4444	1.0887	4.7088	0.9418	20°58′	5
4.2	82° 2′	16°31′	13°31′	0.3125	1.3125	0.4102	1.0882	4.9021	0.9804	7° 3′	5
4.4	80°38′	15°29′	12°38′	0.2941	1.2941	0.3806	1.0873	5.2351	0.8725	45°54′	6
4.6	79°25′	14°34′	11°52′	0.2778	1.2778	0.3549	1.0859	5.4284	0.9047	34°18′	6
4.8	78°20′	13°45′	11°11′	0.2632	1.2632	0.3324	1.0843	5.6222	0.9370	22°40′	6
5.0	77°22′	13° 1′	10°34′	0.2500	1.2500	0.3125	1.0826	5.8164	0.9694	11° 1′	6
5.2	76°30′	12°22′	10° 2′	0.2381	1.2381	0.2948	1.0807	6.1463	0.8780	43°54′	7
5.4	75°42′	11°47′	9°32′	0.2273	1.2273	0.2789	1.0789	6.3410	0.9059	33°52′	7
5.6	74°59′	11°15′	9° 6′	0.2174	1.2174	0.2647	1.0770	6.5355	0.9336	23°50′	7
5.8	74°20′	10°45′	8°41′	0.2083	1.2083	0.2517	1.0752	6.7306	0.9615	13°49′	7
6.0	73°44′	10°18′	8°19′	0.2000	1.2000	0.2400	1.0734	6.9263	0.9895	3°48′	7
6.2	73°11′	9°54′	7°59′	0.19231	1.1923	0.2293	1.0716	7.2539	0.9067	33°34′	8
6.4	72°41′	9°31′	7°40′	0.18519	1.1852	0.2195	1.0699	7.4495	0.9312	24°46′	8
6.6	72°13′	9°10′	7°23′	0.17857	1.1786	0.2105	1.0682	7.6456	0.9557	15°57′	8
6.8	71°47′	8°50′	7° 7′	0.17241	1.1724	0.2021	1.0666	7.8413	0.9802	7° 8′	8
7.0	71°22′	8°32′	6°52′	0.16667	1.1667	0.19445	1.0651	8.1674	0.9075	33°18′	9
7.2	71° 0′	8°15′	6°38′	0.16129	1.1613	0.18730	1.0635	8.3635	0.9293	25°28′	9
7.4	70°38′	7°59′	6°25′	0.15625	1.1563	0.18066	1.0620	8.5596	0.9511	17°37′	9
7.6	70°18′	7°44′	6°12′	0.15152	1.1515	0.17447	1.0607	8.7564	0.9729	9°45′	9
7.8	70° 0′	7°30′	6° 1′	0.14706	1.1471	0.16868	1.0594	8.9534	0.9948	1°52′	9
8.0	69°42′	7°16′	5°50′	0.14286	1.1429	0.16326	1.0581	9.2778	0.9278	26° 0′	10
8.2	69°25′	7° 4′	5°40′	0.13889	1.1389	0.15818	1.0568	9.4747	0.9475	18°55′	10
8.4	69°10′	6°53′	5°31′	0.13514	1.1351	0.15340	1.0556	9.6716	0.9672	11°50′	10
8.6	68°55′	6°41′	5°21′	0.13158	1.1316	0.14890	1.0545	9.8688	0.9869	4°43′	10
∞	60° 0′	0°	0°	0	1	0	1	∞	1	0°	∞

$\left(\frac{d\beta}{d\alpha}\right)_0$	$\left(\frac{d^2\beta}{d\alpha^2}\right)_{-\alpha 0}$	α_{max}	$\left(\frac{d^2\beta}{d\alpha^2}\right)_{max}$
Eq. 43*a*,*b*	**Eq. 45*a***	**Eq. 47*a***	**Eq. 48*a***
∞	∞	0°	∞
50.00	24.25	0°39′	3051
25.00	587.6	1°20′	780.5
16.67	252.9	2° 2′	339.2
12.50	137.6	2°45′	187.0
10.00	85.13	3°29′	116.9
8.33	57.08	4°14′	79.25
7.14	40.44	4°59′	57.03
6.25	29.82	5°46′	42.69
5.56	22.67	6°34′	33.01
5.00	17.64	7°23′	26.06
4.55	13.98	8°13′	21.03
4.17	11.25	9° 5′	17.24
3.85	9.179	9°58′	14.31
3.57	7.542	10°52′	12.03
3.33	6.256	11°48′	10.21
3.13	5.225	12°45′	8.725
2.94	4.387	13°44′	7.516
2.78	3.699	14°46′	6.522
2.63	3.128	15°49′	5.685
2.50	2.652	16°53′	4.979
2.38	2.250	18° 1′	4.376
2.27	1.910	19°10′	3.860
2.17	1.619	20°22′	3.417
2.08	1.370	21°37′	3.034
2.00	1.155	22°54′	2.699
1.92	0.9679	24°14′	2.405
1.85	0.8048	25°38′	2.148
1.79	0.6614	27° 6′	1.921
1.72	0.5342	28°37′	1.719
1.67	0.4200	30°12′	1.539
1.61	0.3149	31°52′	1.379
1.58	0.2439	33° 5′	1.277
Eq. 43*a*,*b*	**Eq. 45*b***		
0.410	0.8410	.....	....
0.385	0.7359	.....	....
0.357	0.6494	.....	....
0.333	0.5880	.....	....
0.313	0.5407	.....	....
0.294	0.5024	.....	....
0.278	0.4705	.....	....
0.263	0.4431	.....	....
0.250	0.4193	.....	....
0.238	0.3982	.....	....
0.227	0.3794	.....	....
0.217	0.3624	.....	....
0.208	0.3471	.....	....
0.200	0.3331	.....	....
0.192	0.3202	.....	....
0.185	0.3084	.....	....
0.179	0.2974	.....	....
0.172	0.2872	.....	....
0.167	0.2778	.....	....
0.161	0.2689	.....	....
0.156	0.2607	.....	....
0.152	0.2529	.....	....
0.147	0.2456	.....	....
0.143	0.2387	.....	....
0.139	0.2322	.....	....
0.125	0.2260	.....	....
0.132	0.2202	.....	....
0.128	0.2147	.....	....
0.125	0.2094	.....	....
0.122	0.2044	.....	....
0.119	0.1997	.....	....
0.116	0.1951	.....	....
0	0	.....	....

kind is shown in *Fig.* 36.

For internal star wheel mechanisms, where the driving gear lies inside the driven gear, or for which $\mu > 1$, the center distance is $r_2 - r_1$, in contrast to the mechanisms previously considered where the center distance is $r_1 - r_2$. It will therefore not be surprising to find that $1 - \mu$ in the various equations is replaced by $\mu - 1$.

The equations can readily be derived from *Fig.* 38*a* in which the same nomenclature is used as in *Figs.* 21*a* and 37*a*.

$$\sin \frac{\alpha_0}{2} = \frac{\mu}{2(\mu - 1)} \quad \text{(20b)}$$

$$\alpha_0 = 2 \sin^{-1} \frac{\mu}{2(\mu - 1)} \quad \text{(21b)}$$

$$\phi_0 = \frac{3\alpha_0}{4} - \frac{\pi}{4} \quad \text{(22b)}$$

$$\beta_0 = \frac{3\mu - 2}{\mu} \sin^{-1} \frac{\mu}{2(\mu - 1)} - \frac{\pi}{2} \quad \text{(23b)}$$

$$r_1 = \frac{a}{\mu - 1} \quad \text{(24b)}$$

$$r_2 = \frac{a\,\mu}{\mu - 1} \quad \text{(25b)}$$

$$s = \frac{a\,\mu}{(\mu - 1)^2} \quad \text{(26b)}$$

$$\rho_0 = 2\,a \frac{\mu}{\mu - 1} \cos\left(\frac{\pi}{4} + \frac{\alpha_0}{4}\right) \quad \text{(27b)}$$

$$\varepsilon = \mu + n \frac{4 - 3\mu}{\pi} \sin^{-1} \frac{\mu}{2(\mu - 1)} + \frac{n\,\mu}{2} \quad \text{(28b)}$$

$$\varepsilon_{max} = n \quad \text{(30b)}$$

$$\frac{3\,\mu_{max} - 4}{\pi\,\mu_{max}} \sin^{-1} \frac{\mu_{max}}{2(\mu_{max} - 1)} + \frac{1}{\mu_{max}} = \frac{n + 2}{2\,n} \quad \text{(31b)}$$

$$\varepsilon_{min} = \frac{3n}{\pi} \sin^{-1} \frac{\mu}{2(\mu - 1)} \quad \text{(32b)}$$

$$\frac{3\,\mu_{min} - 1}{\mu_{min}} \sin^{-1} \frac{\mu_{min}}{2(\mu_{min} - 1)} = \frac{\pi}{2}\,\frac{n + 2}{n} \quad \text{(33b)}$$

$$\varepsilon_{min} = \frac{3(n + 2)\,\mu_{min}}{2(3\,\mu_{min} - 1)} \quad \text{(34b)}$$

$$\nu = \frac{\varepsilon}{n} \quad \text{(35b)}$$

$$\nu_{max} = \frac{\varepsilon_{max}}{n} \quad \text{(37b)}$$

$$\nu_{min} = \frac{\varepsilon_{min}}{n} \quad \text{(38b)}$$

$$\gamma = 2\left[\pi\left(1 - \frac{\mu}{n}\right) - \alpha_0 + \mu\beta_0\right] \quad \text{(39b)}$$

Here again, $\sin \alpha_0/2 = \mu/2(\mu - 1)$ must be smaller than 1, or $\mu > 2$. Another limit is drawn by the requirement that $\alpha_0/2$ must not exceed 60 deg, so that $\mu/2(\mu-1)<\frac{1}{2}\sqrt{3}$, or

$$\mu > \frac{3+\sqrt{3}}{2} = 2.3660 \quad \text{(53b)}$$

The latter limit is higher than the former, and it will be later shown that the practical minimum of μ lies higher still, namely at 2.4399.

The left-hand sides of Equations 31*b* and 33*b* increase with decreasing value of μ, so that the lowest value of μ pertains to the highest value to which the left-hand sides of these equations can amount. The right-hand sides of Equations 31*b* and 33*b* are equal or proportional to $(n+2)/n$, which expression increases with decreasing value of n. The minimum of $\mu = 2.3660$ thus pertains to the maximum of n.

If $\mu = (3+\sqrt{3})/2 = 2.3660$ is substituted for μ_{max} in Equation 31*b*, or for μ_{min} in Equation 33*b*, n results in both cases $(12\sqrt{3}) - 18 = 2.7846$. The smallest practical value of n is, therefore, 3.

The choice of μ greater or less than 1 depends, in the case of internal star wheel mechanisms, on the number of locking shoes n. If n is 1 or 2, μ must be smaller than 1; if n is 3 or more, μ must be larger than 1. Mechanisms pertaining to μ greater or less than 1 are clearly separated in TABLES 7 and 9.

A comparison between TABLES 4 and 7 reveals that external and internal star wheel mechanisms have, for any value of n, a common upper limit of ϵ, whereas the lower limit is higher for internal mechanisms. Internal drives, thus, do not offer possibilities beyond the range of external star wheel mechanisms.

It has been found that, for $n = 2.7846$, the upper and lower limits of μ coincide. As TABLE 7 shows, there is a small margin between the two limits for $n = 3$. That difference increases with increasing n. But since the low values of n are most likely to be required, internal star wheel mechanisms generally leave little latitude in the choice of μ.

In TABLE 8 are indicated the values of μ, if the value ϵ is specified. It is interesting to check by means of Equation 28*b* the values of n, ϵ, and μ for $n = 4$ and $\epsilon = 4$ (*Fig.* 34). In spite of the transcendent form of that equation, $\alpha_0/2$ is in this case 45 deg, and $\mu = 2 + 2\sqrt{2} = 3.4142$. A similar, although less obvious case, occurs for $n = 10$ and $\epsilon = 8$; $\alpha_0/2$ is 36 deg; the relation

$$\sin 36\ \text{deg} = \frac{\sqrt{10 - 2\sqrt{5}}}{4}$$

leads to

$$\mu = \frac{5 + \sqrt{5} + 2\sqrt{5 + 2\sqrt{5}}}{2} = 6.6957$$

Data for designing internal star wheel mechanisms are contained in TABLE 9. It has been found that, for $\mu > 1$, the minimum of $\mu = 2.3660$ pertains to the practically uninteresting number of $n = 2.7846$ locking shoes. The practical minimum is thus μ_{min} for $n = 3$, i.e., $\mu = 2.4399$, and TABLE 9 shows a gap between the values 0.634 and 2.44.

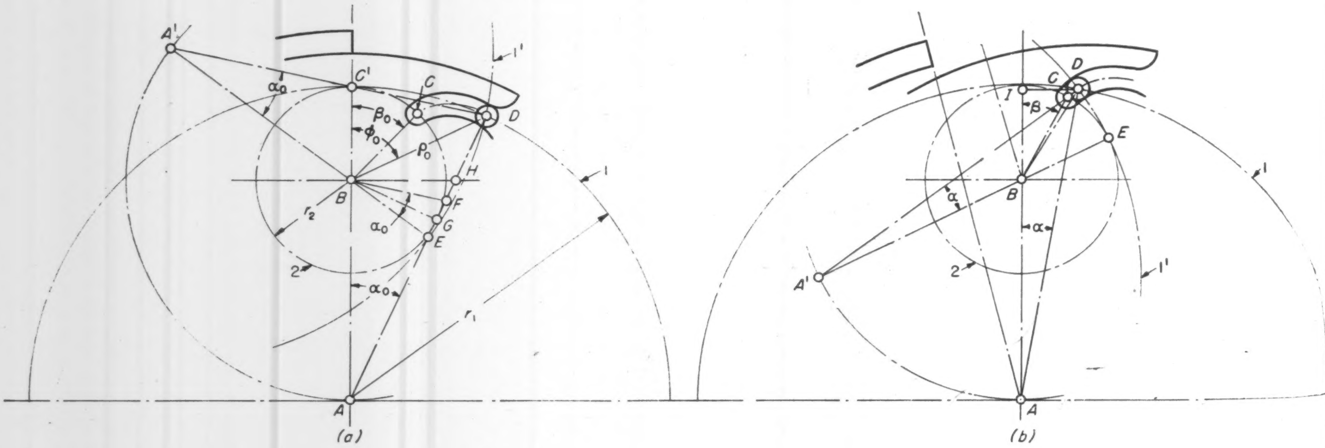
Another gap in the possible range of μ is between μ_{max} for $n = 3$ (i.e., 2.5420), and μ_{min} for $n = 4$ (i.e., 2.7980); the value of $\mu = 2.6$ in TABLE 9 is only there for purposes of interpolation.

The values for $\mu = \infty$ in TABLE 9 confirm the obvious fact that these cases are identical with external drives for $\mu = \infty$ (*Figs.* 24 and 25).

EXAMPLE 11: Design an internal star wheel mechanism, $n = 3$, $\mu = 2.5$ (*Fig.* 33); center distance $a = 4.5$ inches.

The ratio $\epsilon = 2.9575$ is obtained by Equation 28*b*. Since one partial movement of the driven gear comprises 120 deg, the motion occupies (2.9575) 120 deg = 354 deg 54 min, and the standstill 5 deg 6 min of the driving gear.

Fig. 37—Internal star wheel mechanism, $\mu<1$, in the position at the commencement of motion, *a*, and in a general position during the period of motion, *b*



From Equation 20*b*, $\sin \alpha_0/2 = 2.5/2(1.5)$ and $\alpha_0 = 112$ deg 53 min.

From Equation 22*b*, $\phi_0 = \frac{3}{4}\alpha_0 - 45$ deg $= 39$ deg 40 min.

From Equation 23*b*, $\beta_0 = (5.5/2.5)(\alpha_0/2) - 90$ deg $= 34$ deg 10 min.

From Equation 24*b*, $r_1 = 4.5/1.5 = 3$ inches.

From Equation 25*b*, $r_2 = 4.5(2.5)/1.5 = 7.5$ inches.

From Equation 26*b*, $s = 4.5(2.5)/(1.5)^2 = 5$ inches.

From Equation 27*b*, $\rho_0 = 2(4.5)(2.5/1.5)\cos 73$ deg 13 min $= 4.331$ inches.

From Equation 35*b*, $\nu = 2.9575/3 = 0.9858$.

Angle γ need not to be evaluated by means of Equation 39*b*; it is 5 deg 6 min, as found earlier in the example.

The mechanism shown in ***Fig.*** **33** shows both features similar to those for ϵ_{max} (practically no period of standstill), and similar to those for ϵ_{min} (the retarding roller comes into action shortly after the accelerating roller has reached the central position).

When comparing TABLE 3 with TABLE 7, it will be found that ϵ_{min} of internal star wheel mechanisms is always higher than the value ϵ of internal Geneva mechanisms. In contrast to external drives, therefore, internal star wheel mechanisms cannot replace internal Geneva mechanisms.

KINEMATICS: In ***Figs.*** **37*b*** and **38*b*** the star wheel mechanisms are shown in a general position during the period of motion. In both ***Figs.*** **37*b*** and **38*b***, the same nomenclature is used as in ***Fig.*** **21*b***. The derivation of the equation which expresses β as a function of α is analogous to that for external star wheel mechanisms, and results in the following formula which applies for μ greater or less than 1.

$$\beta = 2\tan^{-1}\frac{\sin\alpha}{\mu - 1 + \cos\alpha} - \frac{\alpha}{\mu} \qquad (41a, b)$$

Since Equation 41*a,b* is very similar to Equation 41, the derivations of other equations may be stated in a concise form.

$$\frac{d\beta}{d\alpha} = 2\frac{(\mu-1)\cos\alpha + 1}{(\mu-1)^2 + 1 + 2(\mu-1)\cos\alpha} - \frac{1}{\mu} \qquad (42a, b)$$

$$\left(\frac{d\beta}{d\alpha}\right)_0 = \frac{1}{\mu} \qquad (43a, b)$$

$$\frac{d^2\beta}{d\alpha^2} = -2\mu(\mu-1)(\mu-2) \times \frac{\sin\alpha}{[(\mu-1)^2 + 1 + 2(\mu-1)\cos\alpha]^2} \qquad (44a, b)$$

In the case of $\mu<1$,

$$\left(\frac{d^2\beta}{d\alpha^2}\right)_{-\alpha 0} = \frac{1-\mu}{\mu^2}\sqrt{\frac{2-3\mu}{2-\mu}} \qquad (45a)$$

and in the case of $\mu>1$,

$$\left(\frac{d^2\beta}{d\alpha^2}\right)_{-\alpha 0} = \frac{\mu-1}{\mu^2}\sqrt{\frac{3\mu-2}{\mu-2}} \qquad (45b)$$

$$\frac{d^3\beta}{d\alpha^3} = -2\mu(\mu-1)(\mu-2) \times \frac{-2(\mu-1)\cos^2\alpha + (2-2\mu+\mu^2)\cos\alpha + 4(\mu-1)}{[(\mu-1)^2 + 1 + 2(\mu-1)\cos\alpha]^3} \qquad (46a, b)$$

$$\cos\alpha_{max} = -\frac{\mu^2 + 2(1-\mu)}{4(1-\mu)} \pm \sqrt{\left[\frac{\mu^2 + 2(1-\mu)}{4(1-\mu)}\right]^2 + 2}$$

That result is the same as if in the analogous equation for external star wheel mechanisms $+\mu$ is replaced by $-\mu$, and it is, in this instance, simpler to treat internal and external mechanisms jointly by

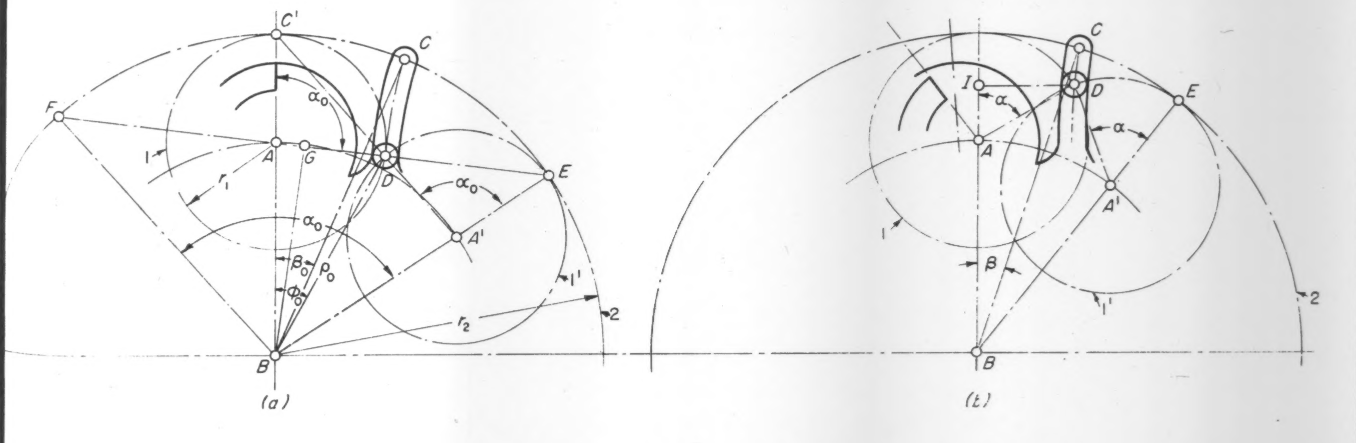


Fig. 38—Internal star wheel mechanism, $\mu>1$, in the position at the commencement of motion, *a*, and in a general position during the period of motion, *b*

using the equation for external drives.

For $0 > \mu > -1$, the value $[\mu^2 + 2(\mu+1)]/4(\mu+1)$ is positive, and

$$\cos \alpha_{max} = -\frac{\mu^2 + 2(\mu + 1)}{4(\mu + 1)} + \sqrt{\left[\frac{\mu^2 + 2(\mu + 1)}{4(\mu + 1)}\right]^2 + 2}$$

In the case of $\mu < -1$, algebraically, the value $[\mu^2 + 2(\mu + 1)]/4(\mu + 1)$ is negative, and

$$\cos \alpha_{max} = -\frac{\mu^2 + 2(\mu + 1)}{4(\mu + 1)} - \sqrt{\left[\frac{\mu^2 + 2(\mu + 1)}{4(\mu + 1)}\right]^2 + 2}$$

The requirements $\cos \alpha_{max} > \cos \alpha_0$ leads, for $0 > \mu > -1$, to the same condition as has been found for external star wheel mechanisms, i.e., $\mu^2(\mu^3 - 6\mu - 4) < 0$.

For $\mu < -1$, the inequality sign changes, due to the varied sign of the square root, so that $\mu^2(\mu^3 - 6\mu - 4) > 0$.

Because a negative value is now attributed to μ, for internal star wheel mechanisms, the inequality signs of Equations 53*a* and 53*b* must be reversed.

In *Fig.* 26, the curve $y = \mu^2(\mu^3 - 6\mu - 4)$ lies, in the range of $0 > \mu > -0.634$ (compare Equation 53*a*), and of $\mu < -2.366$ (compare Equation 53*b*), below the μ axis. The condition $\cos \alpha_{max} > \cos \alpha_0$ is thus complied with for $0 > \mu > -0.634$, but not for $\mu < -2.366$.

Returning again to the positive notation of μ for internal mechanisms, the angular acceleration has a maximum during the period of acceleration if $\mu < 1$. For $\mu > 1$, the maximum pertains to a position before the commencement of motion, and the highest actual value pertains to the commencement of motion.

The maximum of the angular acceleration is thus only of interest for mechanisms with $\mu < 1$. It pertains to

$$\alpha_{max} = \cos^{-1}\left\{-\frac{\mu^2 + 2(1 - \mu)}{4(1 - \mu)} + \sqrt{\left[\frac{\mu^2 + 2(1 - \mu)}{4(1 - \mu)}\right]^2 + 2}\right\} \quad \ldots\ldots\ldots\ldots (47a)$$

and it amounts to

$$\left(\frac{d^2\beta}{d\alpha^2}\right)_{max} = -2\mu(1 - \mu)(2 - \mu) \times \frac{\sin \alpha_{max}}{[(1 - \mu)^2 + 1 + 2(1 - \mu)\cos \alpha_{max}]^2} \quad \ldots\ldots\ldots (48a)$$

The value of $d^3\beta/d\alpha^3$, for $\alpha = 0$, is $-2(1 - \mu) \times (2 - \mu)/\mu^3$, and is a measure of the rate at which the angular acceleration diminishes in the central position.

In TABLE 9 are the values $(d\beta/d\alpha)_0$, $(d^2\beta/d\alpha^2)_{-\alpha_0}$, α_{max}, and $(d^2\beta/d\alpha^2)_{max}$, the two latter only for $\mu < 1$.

EXAMPLE 12: Investigate the kinematic properties of the mechanism considered in Example 11 ($n = 3$, $\mu = 2.5$), for $\omega = 1$ rad per sec.

The angular velocity at the start of motion is zero, and rises to $1/2.5 = 0.4$ rad per sec in the central position, according to Equation 43*a,b*.

The angular acceleration at the start of motion is, from Equation 45*b*, $(1.5/2.5^2)\sqrt{5.5/0.5} = 0.796$ rad per sec², and is the highest value actually occurring.

In *Fig.* 39 are diagrams of the values β, $d\beta/d\alpha$, and $d^2\beta/d\alpha^2$, for the mechanism considered in Examples 11 and 12. Acceleration and retardation occupy each 112 deg 53 min, the uniform motion lasts 129 deg 8 min, and the standstill 5 deg 6 min.

Scrutiny of TABLES 5, 6, 8 and 9, shows that the extreme values of the angular acceleration are, for $\mu > 1$, about equal for external and internal star wheel mechanisms, mostly to a slight advantage of the former. For $\mu < 1$, the internal mechanisms have a more favorable course of motion.

MODIFICATIONS: Internal Geneva mechanisms proved to be unsuitable for modifications; internal star wheel mechanisms permit limited modifications.

Equation 49 applies also to internal star wheel mechanisms. It reveals that for one or two stations $m_{max} = \infty$, but that it is impossible to provide, for any other finite number of stations, more than one group of driving rollers.

Equation 50 applies likewise to internal star wheel mechanisms, and gives more detailed information. It has been found under MODIFICATIONS in Part 2 that two groups of driving rollers are bound on the condition that $\alpha_0 \leqq 60$ deg. As TABLE 9 shows, only values of μ up to 0.5 and $\mu = \infty$ are applicable.

In *Fig.* 35, $\mu = 0.3420$ and $\epsilon = 0.5$, a second group

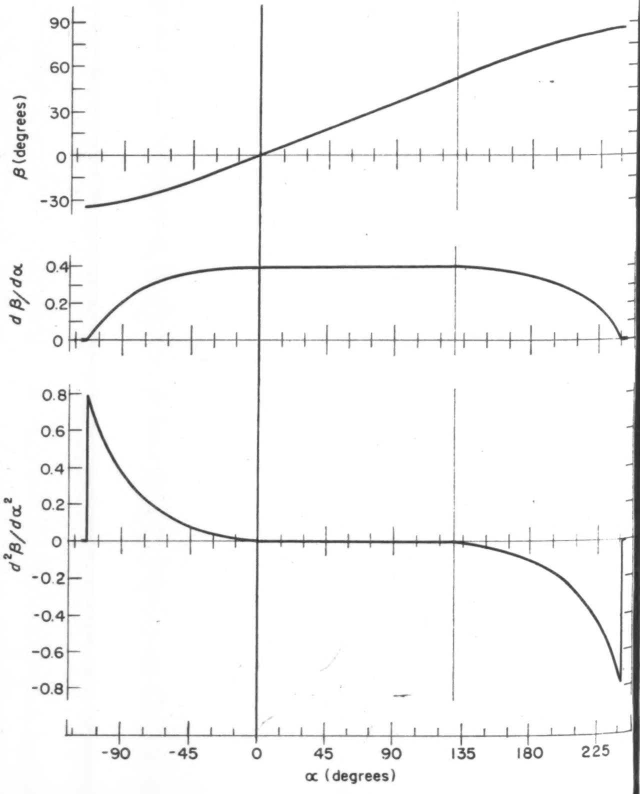


Fig. 39—Diagram of motion for the mechanism shown in *Fig.* 33

of driving rollers is indicated in dotted lines. Two further groups could be arranged, one in each quadrant. As Equation 49 indicates, $m = n/\epsilon = 2/0.5 = 4$, so that no standstill is left with four groups of driving rollers.

The groups of driving rollers need not be spaced equally, and it is also possible to lay out internal star wheel mechanisms for varying partial movements.

Design and Production: All that has been stated about designing and machining of external star wheel mechanisms applies with the necessary modifications to internal mechanisms. The combination of elements for uniform and nonuniform motion often meets with difficulties, due to the restricted space available and to restrictions imposed by the arrangement of the bearings in internal gearing. Internal involute gears, the preferable means for imparting uniform motion in this case, themselves present a difficulty since facilities for cutting them are not alway readily available. Fortunately, the elements for imparting the uniform motion are dispensable in most cases of internal star wheel mechanisms.

The condition under which special elements for imparting uniform motion can be omitted is the same as for external drives, i.e., $\mu[(2\pi/n)-2\beta_0]<2\alpha_0$, which can be transformed in a similar way as demonstrated for external drives, for $\mu<1$ ($n = 1$ or 2), into

$$\mu > \frac{2\sin\left(\frac{\pi}{6}\,\frac{2-n}{n}\right)}{2\sin\left(\frac{\pi}{6}\,\frac{2-n}{n}\right)+1} \qquad \text{(52a)}$$

and for $\mu>1$ ($n = 3$), into

$$\mu < \frac{2\sin\left(\frac{\pi}{6}\,\frac{2+n}{n}\right)}{2\sin\left(\frac{\pi}{6}\,\frac{2+n}{n}\right)-1} \qquad \text{(52b)}$$

For $n = 1$, μ results larger than 0.5, so that no special uniform motion elements are required for values of μ between 0.5 and 0.6302.

For $n = 2$, μ results larger than 0, so that these elements can be dispensed with in all cases.

For $n = 3$, μ results smaller than 2.8795; since that value exceeds μ_{max}, elements for uniform motion can be dispensed with in any case.

For $n = 4$, μ results smaller than 3.4142. That value is identical with μ_{max} so that special elements for the uniform motion are in no case necessary; it is, however, advisable to incorporate them in the indicated extreme case, to insure the continuity of motion (see *Fig.* 34, where there is one intermediate roller).

The ranges of μ for higher numbers of stations for which elements for uniform motion can be omitted, are

n	μ *Range*
5	3.1676 to 3.9563
6	3.5434 to 4.5016
7	3.9219 to 5.1673
8	4.3011 to 5.5973
9	4.6830 to 6.1461
10	5.0643 to 6.6953

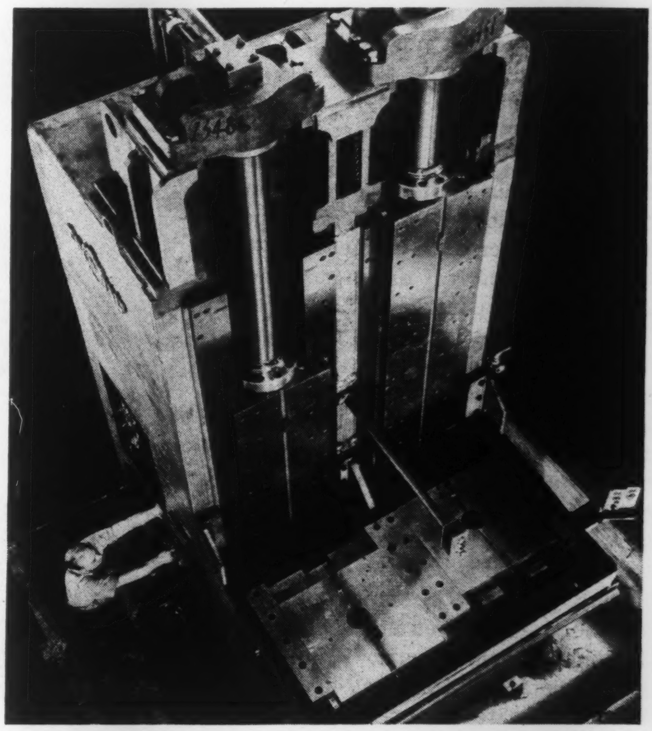
As shown by TABLE 7, these ranges occupy a considerable part of the full ranges of μ, with the exception of $n = 1$. It is thus possible, in contrast to gears for uniform motion, to simplify a drive by the arrangement of internal mechanisms. The three internal mechanisms shown in *Figs.* 33, 35 and 36, for example, consist only of the elements for nonuniform motion, and the mechanism shown in *Fig.* 34 could be carried out in the same way. If any of these mechanisms were replaced by an equivalent external star wheel mechanism, special parts for imparting uniform motion would be required.

A milling device similar to that shown in *Fig.* 32 can be used for machining the hypocycloidal or pericycloidal slots, or the device can be laid out to suit the requirements of external and internal mechanisms. The difference lies mainly in the location of the bushing which guides the milling cutter, and in the means for clamping down the gear to be used as the driving involute gear.

In Part 4, the last of this series, intermittent mechanisms for intersecting and crossing shafts will be discussed.

Giant Broach Has 90-inch Stroke

TYPICAL of some of the giant new special machines currently being built to expedite production of parts needed for the defense effort is this vertical surface-broaching machine under construction at Colonial Broach Co. Overall height of 28½ feet makes this vertical broaching machine one of the largest ever built. The dual ram, capable of continuous automatic operation, has a 90-inch stroke for both rams, permitting completion of many operations in one stroke rather than two.



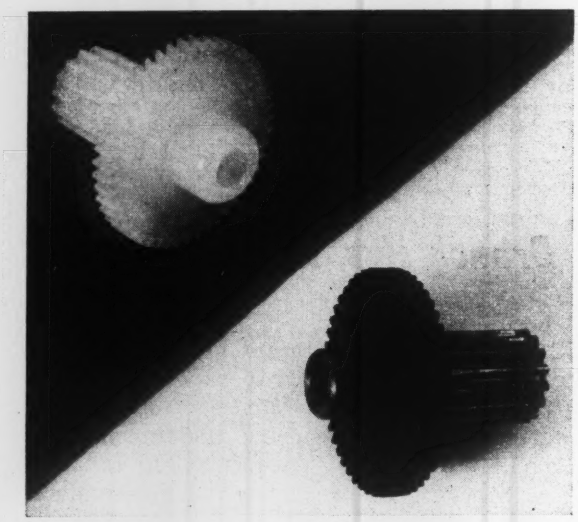
PRODUCTION AND

DESIGN

Modern Practices in Manufacture

Plastics Components

. . . provide improved characteristics,increased production and lower costs



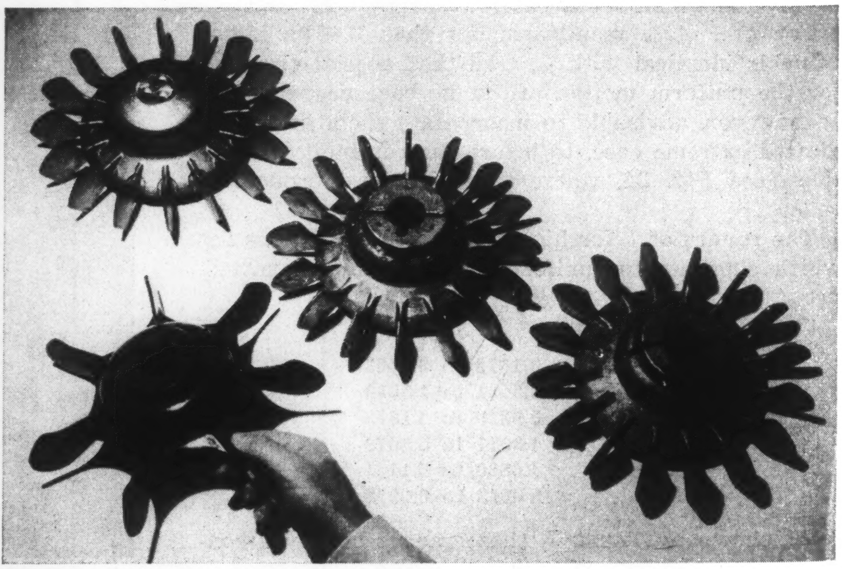
UNUSUAL cost savings have been obtained on gears for General Electric Co. oscillating fans by replacing assembled metal gears with one-piece molded nylon gears. A molded nylon worm wheel and pinion, shown accompanying, resulted in a cost saving of 65 per cent, as compared with the original construction of a steel pinion and laminated plastic gear where hobbing, cutting and assembly operations were required.

Molded by GE in a Fellows-Leominster injection press especially designed for economical nylon molding, the nylon wheel and pinion require no machining operations. Assembly operations are also eliminated since the two parts are molded as one unit. Tests show that the nylon gears, which operate at 32 rpm with a maximum torque of 6.75 ounce-inches, have excellent wear characteristics as compared with the previous steel and laminated gears. Quieter operation, in addition to substantial cost savings, has also been obtained.

PLASTIC has found another use in the electric motor field, where it now is being used to replace critical aluminum and bronze for blowers in Westinghouse totally-enclosed,fan-cooled a-c motors. The plastic blowers consist of a polyester resin reinforced with glass fiber. Glass fiber reinforcement has been found to be superior to organic fiber reinforcement because of increased resistance to chemical attack, and increased strength per pound.

The plastic blower has many advantages over the aluminum and bronze blowers it replaces. It is unaffected by the chemical agents that attack the metals. Hence, it is desirable on motors used in refineries, chemical plants, and process industries where corrosive atmospheres may be present.

The plastic blower is as much as one third lighter in weight than its metal counterpart. While in some instances this may be but a matter of a few ounces, the reduction of inertia where frequent, rapid reversals are required is well worthwhile. Preliminary tests indicate that the plastic blower has better resistance to abrasion.



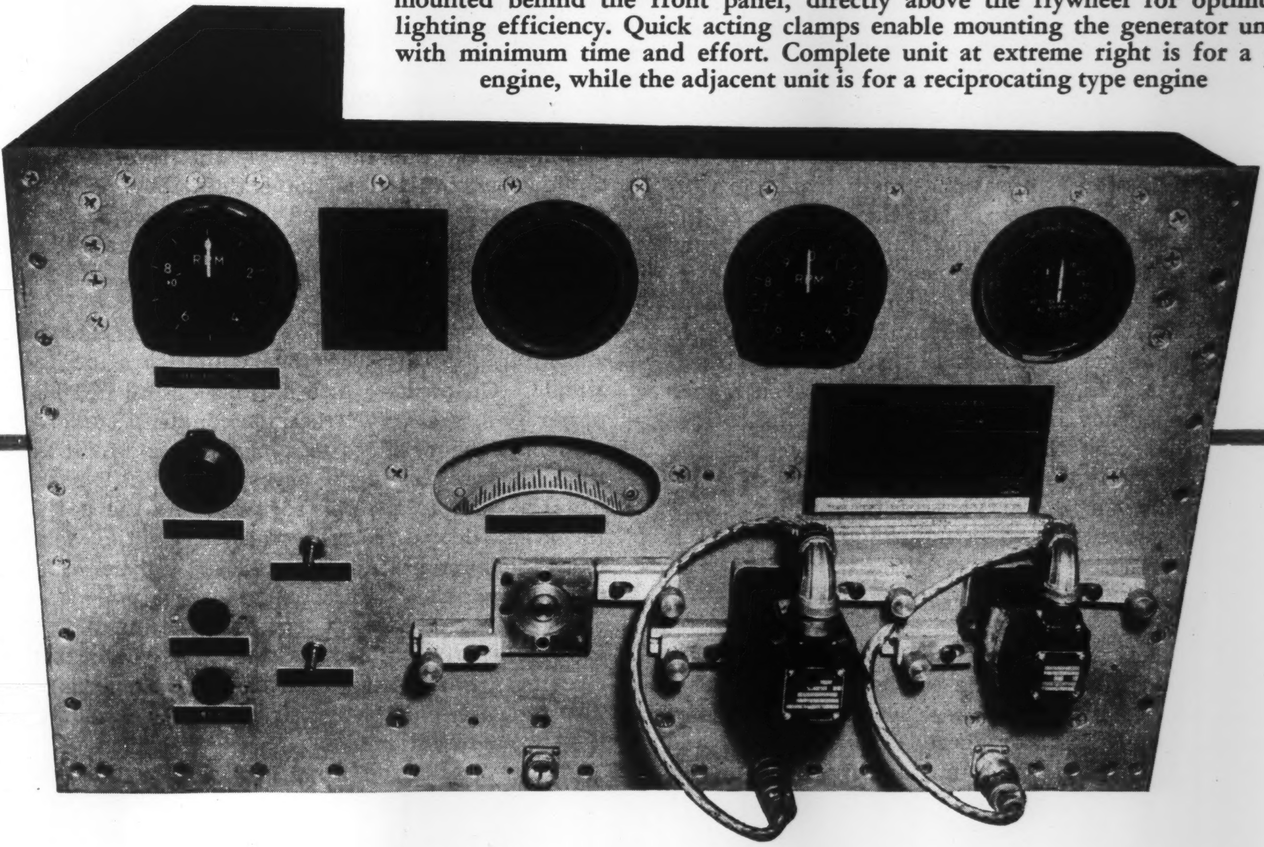


Fig. 1—Three complete generator-type engine tachometers can be checked simultaneously for calibration accuracy with this tester. The stroboscope lamp is mounted behind the front panel, directly above the flywheel for optimum lighting efficiency. Quick acting clamps enable mounting the generator units with minimum time and effort. Complete unit at extreme right is for a jet engine, while the adjacent unit is for a reciprocating type engine

STROBOSCOPE TACHOMETER

Heart of design is flywheel marking with associated flashing light source

By Alvin B. Kaufman
Los Angeles, Calif.

IN AIRCRAFT work it is necessary to check generator - type engine tachometers periodically, throughout their normal operating range, to aid accurate synchronization of engine speeds in flight. Factors entering into the design of a fixed-frequency type stroboscopic test unit for accurately checking tachometer calibration over a wide range of speeds will be discussed in this article, with special attention to the design of the stroboscope flywheel.

To meet Army and Navy Airforce procurement specifications, aircraft engine tachometers are allowed a maximum calibration error of 25 rpm. The accuracy of speed indication is controlled by the drag-cup mechanism in the indicator, and necessary corrective adjustments to this mechanism must be performed with the aid of a reliable testing unit. Currently, generators of two types are used in engine speed indicator units.

Reciprocating-type aircraft engines use either a two-pole or four-pole generator with associated indicator. Practically all such engines use the four-pole generator which is driven at one-half engine speed, while the indicator reads directly in engine rpm. In this type application the generator operating speed ranges from 300 to 1500 rpm.

Two-pole generators are used with turbojet engines and, regardless of engine speed range, the peak generator speed is limited to 4200 rpm by appropriate gearing. Indicator calibrations read from zero to 100 per cent turbine speed. In the jet engine, the accuracy is particularly important, a few per cent error representing the difference between poor performance and burning-up of the engine. Here, accuracy of indicator calibrations must be held within one-half of one per cent of true turbine speed. Needless to say, it is highly desirable that an even higher degree of accuracy be attained in a test unit, especially for checking the jet engine tachometers. The unit to be described adequately satisfies test requirements for checking both types of tachometers accurately throughout their operating ranges.

Tester Checks Calibration Accuracy

Briefly, the three-station tester, *Fig.* 1, comprises a variable-speed drive to the tachometer generator couplings in the mounting pads, a master tachometer for setting the generator speeds approximately, and a built-in stroboscopic flash unit and flywheel for setting the generator speeds accurately in order to check the engine tachometer calibrations.

Two stroboscope types are available commercially, the variable flash-frequency and the fixed flash-frequency. The latter is used in the tester illustrated since it relies solely upon ac power line frequency for flash rate. In most utility systems, ac power deviates less than one-tenth of a cycle from the nominal frequency, which is sufficiently constant for operation of the test unit. If extreme accuracy is required, an electrically driven tuning fork can be utilized in such a unit to produce absolutely constant flash frequency. In such a case it is advisable to select a tuning fork frequency that will avoid the necessity of closely spaced divisions on the rotary member to be observed.

Since a light flash of long duration will cause "smear" of the divisional markers, a flash circuit and lamp capable of emitting sharp pulses of light is highly desirable in a stroboscope. A standard neon lamp cannot be used across the power line because its light-output time would be excessively long. With special vacuum tube circuits, high speed on-off keying can be accomplished, but in general, the level of flash illumination obtained is not satisfactory. The use of a lamp especially designed for stroboscopic service is most desirable. The Sylvania 631-P1 Strobotron used in this design has adequate light output and suitable mechanical dimensions.

Typical of stroboscope flash circuits is the one shown in *Fig.* 2. The theory of operation is quite simple. On positive alternations of the 631-P1 plate power line, the 117Z6 rectifier conducts current, thus charging the series 4-mfd condenser. At the same time the voltage drop across the rectifier supplies negative bias to the control grid. As the positive alternation drops to zero voltage or the condenser charging current falls, the 631-P1 tube's bias is removed and the still charged 4-mfd condenser discharges through the gaseous conducting path in the glow tube. The series resistances in the control grid circuits are necessary to prevent excessive current flow through the grids during the dynamic cycle of the tube's operation.

As the Strobotron glow tube has a cold cathode, instantaneous operation is limited only by the heating time delay of the 117Z6 rectifier. This rectifier may be replaced by a selenium type rectifier, provided a series resistor of adequate value is used, to limit peak rectifier current and to supply adequate tube bias. The circuit components should not be grounded because of the direct power line input, but a safety ground should be attached to the apparatus frame.

In the fixed-frequency type stroboscopic tachometer, the marked flywheel plays a highly important role, and in order to design a wheel with appropriate markers suitably spaced, a number of factors must be considered. The problem, simply stated, is: in order to "stop" any pattern for a given rotational speed, that pattern or succession of markers should

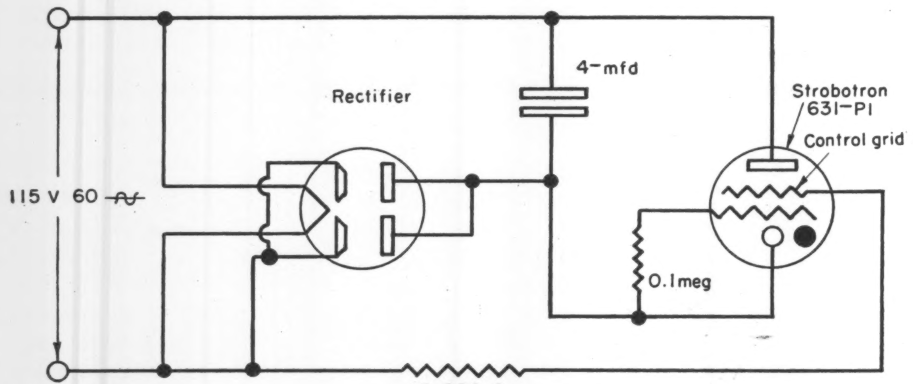


Fig. 2—Schematic diagram of a typical stroboscope flash lamp circuit. In this instance, a rectifier tube is used to direct current impulses to the lamp

appear stationary and in the same position for each stroboscope flash. The wheel design may be such as to present from one to three convenient patterns for establishing tachometer shaft speed, or stroboscope wheel speed, at predetermined levels.

The wheel design calculations are based on the fact that there is a given travel or unseen movement of the pattern between flashes of light. The number of flashes per second is equal to the line frequency times k. The constant k is 1 where the stroboscope lamp flashes only once for each cycle, and 2 where the lamp flashes at both positive and negative peaks of the cycle. Assuming then that a flash will occur either on both peaks of the alternating current cycle, or only on positive or negative peaks, the time between flashes would be

$$t = \frac{1}{fk} \qquad (1)$$

where t = time, seconds, and f = line frequency, cycles per second.

Since in most locations power line frequency is 60 cycles per second, this figure will be used for all computations in this article. The time between flashes then would be 1/60 or 0.01666-second, with the stroboscope lamp flashing only once every cycle. Where t is not a convenient decimal quantity, it is better to use the fraction instead of the decimal in order to calculate marker spacing in terms of whole numbers.

To determine the location for the marker lines, the angular movement of the stroboscope flywheel between light flashes must be determined according to the rotational speed. The wheel speed may be expressed in revolutions per second if desired, so as to work with a common time factor. Then the angular spacing, θ degrees, between markers for one given speed is

$$\theta = \frac{360 n_m t}{60} = 360\, n_s t \qquad (2)$$

where n_m = wheel speed, rpm; and n_s = wheel speed, rps.

A wheel of this design would appear to be stationary under stroboscopic light at complete multiples of the speed, such as $n_m \times 17$, $n_m \times 18$, etc. To design a wheel which will synchronize at multiples of the desired speed increments then θ must be calculated using the difference between consecutive speeds. The separating angle between marks on the flywheel will be

$$\theta = 360 n_{s1} t - 360 n_{s2} t \qquad (3)$$

Most engraving machines or mills are designed so that the part to be engraved may be indexed and engraved at angular positions. However, where this method of engraving is not available, the length of arc or the circular center-distance between markers on the stroboscope wheel may be found by the formula

$$S = \frac{\pi r \theta}{180} \qquad (4)$$

where S = arc length, inches; r = wheel radius, inches; and θ = angle between markers, degrees.

Actually, not the same marks are seen at each different speed, but since the incremental increase is in even steps, for each higher speed the flash simply makes visible a wider spaced pair of marks. The angular spacing between the markers is a constant,

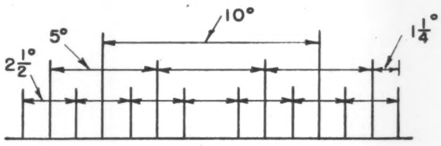


Fig. 3—Above—Ideal pattern for stroboscope flywheel markings to designate speed increments of 25, 50, and 100 rpm. Limited wheel diameter prevented using this pattern in the test unit shown in *Fig.* 1

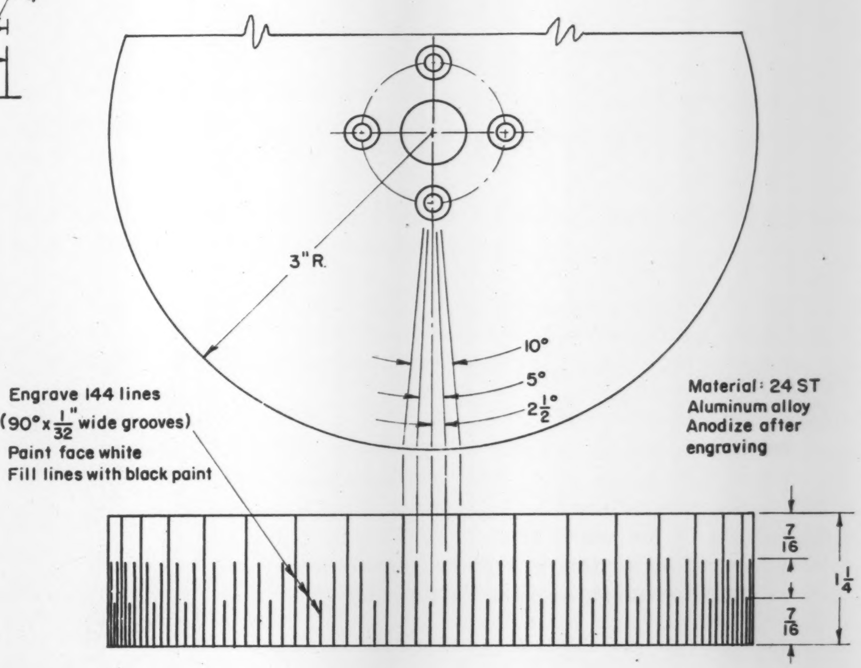


Fig. 4 — Right — Detailed drawing of the stroboscope wheel used in the tachometer test unit shown in *Fig.* 1. Wheel circumference would not permit engraving the ideal pattern as shown in *Fig.* 3 since the marker spacing would then be too close

proportional to the speed increment. With this spacing engraved around the wheel, the marks will synchronize at any multiple of the selected increment.

One or more sets of markers may be calculated for the increments of speed selected and, if possible, the wheel circumference should be great enough to accommodate the different sets of markers required, as in *Fig.* 3. Each set should be engraved to different heights so that each group may be separately distinguished under stroboscopic light.

As an example, consider the problem of designing the stroboscope flywheel for the tester shown in *Fig.* 1. It was desirable in this instance to check the accuracy of aircraft engine tachometers at every 25, 50, and 100-rpm division throughout the operating range.

Determining Marker Characteristics

To establish a series of markers for the 100-rpm increments speeds of 1700, 1800, and 1900 rpm were used in the calculations, resulting in ten-degree spacing for this set of markers (Equation 3). To locate markers for the intermediate 50-rpm increments, speeds of 1750, 1800, and 1850 rpm were used in the calculations, resulting in five-degree spacing. By similar procedure, two and one-half degree spacing was established for the 25-rpm divisions.

At this point it should be noted that the 50-rpm markers will synchronize at every multiple of 50 rpm throughout the speed range. Also, where these markers are used in combination with other markers representing some multiple of 50 rpm, both sets of markers will synchronize at certain speeds. For example, on the wheel with 50 and 100-rpm markers, at every 100 rpm both sets of markers will synchronize, making visible two sets of markers, identified of course by their difference in height.

The same situation exists for the 25-rpm markers. At speeds of 1725 rpm, 1775 rpm, etc., where neither the 50 nor 100-rpm increments are whole submultiples, only the 25-rpm markers will appear stationary under the stroboscope light. At the 50 and 100-rpm speed increments, the 25-rpm markers will also appear stationary. Thus for the three-speed wheel, three different marker-patterns will be visible: One set of markers at the 25-rpm intermediate speeds, two sets at the 50-rpm intermediate speeds, and all three sets at the 100-rpm speeds.

Previous calculations have indicated that, in this instance, the different groups of markers require angular spacings of two and one-half, five, and ten degrees. However, because of the comparatively small circumference of the stroboscope wheel, the patterns could not be engraved separately as in *Fig.* 3, which requires that adjacent lines be only one and one-quarter degrees apart.

In the actual engraving pattern, *Fig.* 4, the longest and shortest markers are each spaced 10 degrees apart, while the intermediate markers are spaced 5 degrees. However, an optical phenomenon makes it possible to use this marking system even for the multiples of 25 rpm.

Perhaps the clearest understanding of this phenomenon may be secured by examining the shortest (50 rpm), and the highest (100 rpm) markers: The short markers are spaced midway between the high markers therefore, at multiples of 50 rpm both markers, being spaced five degrees apart, will appear to be stationary. However, as the observed pattern consists of one marker replacing the other, the top section of the long marker will not be as clearly visible because it is not in the same location for each flash whereas the short marker or the lower segment of the long marker is.

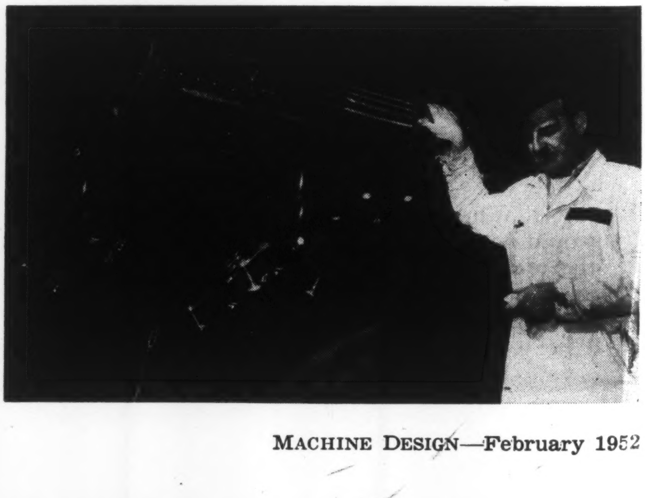
A similar phenomenon occurs with the 25-rpm markers, except that the short marker does not complete the intermediate marker. Since this partial void caused by the short marker occurs only every fourth flash, the optical pattern is satisfactory. As shown in *Fig.* 1, a legend plate attached to the panel of the stroboscopic test unit avoids inadvertent misinterpretation of patterns.

Deicing System Has Fast Cycle

THE NAVY'S AD-Skyraider, a carrier-based attack bomber, sports an improved pneumatic deicing system. More efficient in breaking ice formations and capable of withstanding high speeds without lifting from wing surfaces, the new deicer exerts greater strain between ice and rubber to produce faster ice-breaking action.

Developed by the B. F. Goodrich Co., the deicer employs smaller air tubes, greater air pressure, and a faster inflation-deflation cycle than previous units. Expanding tubes are reduced to 1¼ inches diameter, and air pressure is increased from 7 to 15 psi. Use of a solenoid manifold system provides alternate pressure and vacuum for more rapid inflation and deflation.

These changes in the pneumatic deicing system were found to be most practical in providing adequate protection against "mush" ice, which may flex and fail to break away in the operation of slower mechanical deicing systems.



Beam Deflection

By W. L. Tryon*
Schenectady, N. Y.

CALCULATING deflections of beams can be a tedious procedure, particularly if deflection plots are required for entire lengths or if more than one load is applied as in *Fig.* 1. Charts presented in this data sheet give deflection data rapidly for most of the common beam cases. These solutions include many that are needed in dealing with shafts of rotating machines, bars or elements subjected to centrifugal force and, in general, structural parts requiring critical analysis of deflection.

Standard equations for deflection are the bases of the accompanying charts. These fundamental equations are shown in TABLE 1 with sketches of the beam cases and references to the numbered solution charts which appear on succeeding pages. In these equations, y = deflection in the vertical direction, inches; W = total load, pounds; E = modulus of elasticity, psi; and I = moment of inertia, inches^4. The point at which deflection is required along the length of the beam is commonly noted as x or x' (inches) for all cases. Other symbols are defined in the classifying sketches of TABLE 1.

Certain limiting conditions apply to these equations as well as to the charts. The beam must be of homogeneous composition and of uniform moment of inertia over its length. The proportional limit of the beam material must not be exceeded. The applied load and the reactions are assumed to remain perpendicular to the axis of the beam. Additionally, the length of the beam must be significantly greater than the depth. For example, with a rectangular section, these equations err by more than 5 per cent if the beam length is less than 8 times the beam width. If length to depth ratio is even lower, deflection due to shear must be considered as well as that caused by bending.

The graphical solutions given by the charts are two-step procedures. *Figs.* 2 to 8 give a calculation factor, K (or K'), which applies for all cases in the expression:

$$y = K\frac{l^3}{EI}$$

The calculation factor K is dependent upon the conditions of loading, the point at which deflection is to be calculated (x), and the concentrated or total distributed load (W).

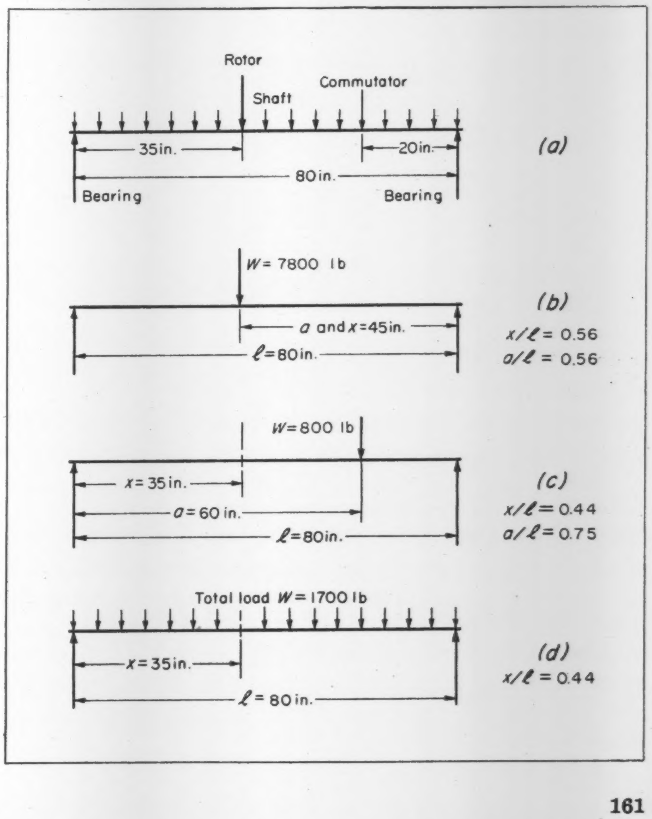
After K has been determined from *Figs.* 2 to 8, y can be quickly determined for steel beams from the nomogram of *Fig.* 9. For this nomogram, modulus of elasticity, E, has been assumed equal to 28,000,000 psi for reasons explained later. This chart also includes facility for dealing with round beams or shafts directly in terms of shaft diameter.

In summary, procedure for using the charts is:

1. Determine applicable chart from TABLE 1
2. Find calculation factor K (or K') from *Figs.* 2 to 8
3. Find deflection y from *Fig.* 9.

EXAMPLE: The rotor of a motor weighs 7800 lb; its commutator weighs 800 lb. Distance between bearings is 80 inches, centerline of the principal weight is 35 inches from one bearing, and the commutator is 20 inches from the other bearing center. The shaft

Fig. 1—Example of a motor shaft subjected to a compound load. General conditions shown at *(a)* can be broken down into three component problems: *(b)* effect of rotor weight, *(c)* effect of commutator, and *(d)* effect of distributed weight of shaft



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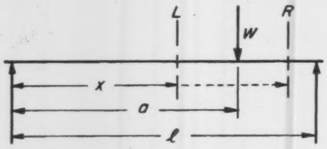
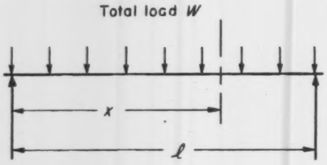
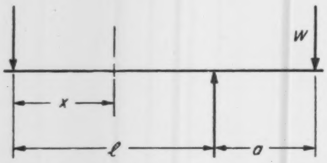
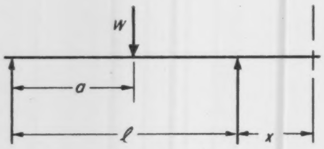
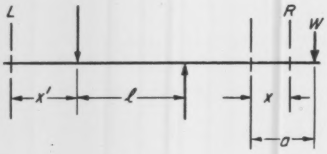
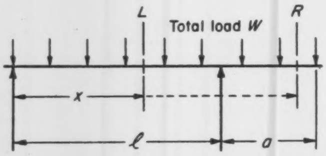
[*] Formerly supervisor of drafting, small and medium motor division, General Electric Co., Schenectady, N. Y., now retired.

Data Sheet

Table 1—Fundamental Beam Equat

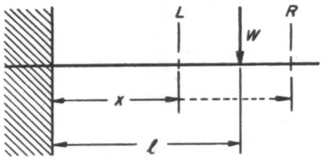
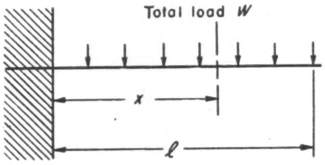
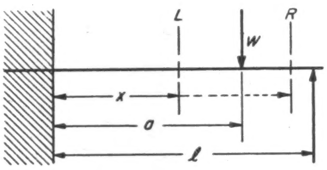
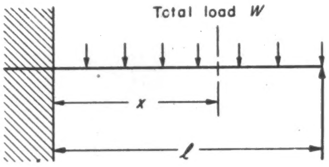
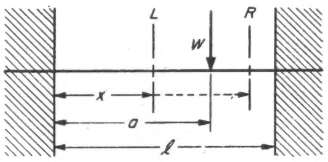
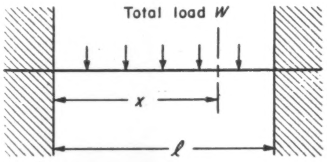
Beam	Deflection Equation	Fig. No.
	$y_L = \frac{Wx\,(l-a)}{6EIl}\,[l^2 - x^2 - (l-a)^2]$ $y_R = \frac{Wa\,(l-x)}{6EIl}\,[l^2 - (l-x)^2 - a^2]$	2*a*
	$y = \frac{Wx}{24\,EIl}\,(l^3 - 2\,lx^2 + x^3)$	2*b*
	$y = \frac{Wax}{6\,EIl}\,(l^2 - x^2)$	3*a*
	$y = \frac{Wax}{6\,EIl}\,(l^2 - a^2)$	3*b*
	$y_R = \frac{Wx}{6\,EI}\,(3\,ax - x^2 + 2\,al)$ $y_L = \frac{Wax'l}{6\,EI}$	4
	$y_L = \frac{Wx(l-x)}{24\,EI(l+a)}\left[x(l-x) + l^2 - 2a^2\left(1 + \frac{x}{l}\right)\right]$ $y_R = \frac{W(x-l)}{24\,EI(l+a)}\,[4la^2 + 6a^2\,(x-l) - (x-l)^2\,(4a - x + l) - l^3]$	5

weighs 1700 lb, and its moment of inertia is 490 inches^4. Determine the deflection at the centerline of the rotor. This problem, diagramed in *Fig.* 1, actually consists of three separate cases.

According to TABLE 1, *Fig.* 2*a* is applicable for the concentrated loads of the rotor and commutator, *Fig.* 2*b*, for the distributed weight of the shaft. For the concentrated loads, assignment of the dimensions x and a with respect to one bearing or the other is guided by the notation $x > l - x$ on *Fig.* 2*a*. Dimension a is referred to the same bearing as x. After these symbols have been properly applied, the ratios x/l and a/l are determined for each problem, as noted in *Fig.* 1.

Values of K and K' (the prime denoting only a different scale) are then easily found on *Fig.* 2 by adherence to the sequence shown in the keys. For the rotor, enter the grid at $x/l = 0.56$, descend vertically to the curve (interpolated) of $a/l = 0.56$, proceed horizontally to the diagonal (interpolated) of $W = 7800$, and descend vertically to $K = 158$. For the commutator, a similar procedure with $x/l = 0.44$, $a/l = 0.75$, and $W = 800$ yields $K = 11$. For the distributed weight of the shaft, the same procedure is followed except that Curve A is used instead of the curves of a/l and scale K' instead of K. Hence with $x/l = 0.44$, Curve A, and $W = 1700$, the solution is $K' = 22$.

ed by Charts in Figs. 2 to 8

Beam	Deflection Equation	Fig. No.
	$y_L = \frac{Wx^2}{6EI}(3l - x)$ $y_R = \frac{Wl^2}{6EI}(3x - l)$	6*a*
	$y = \frac{Wx^2}{24\,EIl}[2l^2 + (2l - x)^2]$	6*b*
	$y_L = \frac{Wx^2(l - a)}{12\,EIl^3}[3al(2l - a) - 2lx(l + a) + a^2x]$ $y_R = \frac{Wa^2\,(x - a)}{12\,EIl^3}[3l^2\,(l - a) - (x - a)^2\,(3l - a)]$	7*a*
	$y = \frac{Wx^2\,(l - x)}{48\,EIl}(3l - 2x)$	7*b*
	$y_L = \frac{Wx^2(l - a)^2}{6\,EIl^3}[2a\,(l - x) + l\,(a - x)]$ $y_R = \frac{Wa^2(l - x)^2}{6\,EIl^3}[2x\,(l - a) + l\,(x - a)]$	8*a*
	$y = \frac{Wx^2}{24\,EIl}(l - x)^2$	8*b*

The total of the calculation factors determined at the center line of the rotor is $158 + 11 + 22 = 191$. Then, in *Fig.* 9, the value of $K = 191$ and $l = 80$ inches are joined by a straight line. From the intersection of this line with the centerline of the nomogram, a line is projected through $I = 490$ inches^4, the known moment of inertia. Extending this line to the deflection scale gives $y = 0.0071$-inch.

The nomogram of *Fig.* 9 can be used for steel shafts having slightly reduced diameters at the bearings with reasonably accurate results. It was for this reason that the conservative value of 28,000,000 psi was selected for E. Simply reducing the chart value of y by 10 per cent will give a result corresponding to $E = 30$ to 31,000,000 psi.

It should be recognized that *Fig.* 9 is valid only for steel. For other materials, with different moduli of elasticity, deflection must be calculated from the equation, $y = Kl^3/EI$.

In the preceding example, deflection for a compound load was determined from the sum of a number of calculation factors. With some cases, K values are not additive. For example, if a cantilever such as shown in *Fig.* 5 is subjected to a number of loads, the effective length dimension l is different for each load. Hence deflection for each load must be determined from $y = Kl^3/EI$ or *Fig.* 9. Values of y then can be added.

Data Sheet

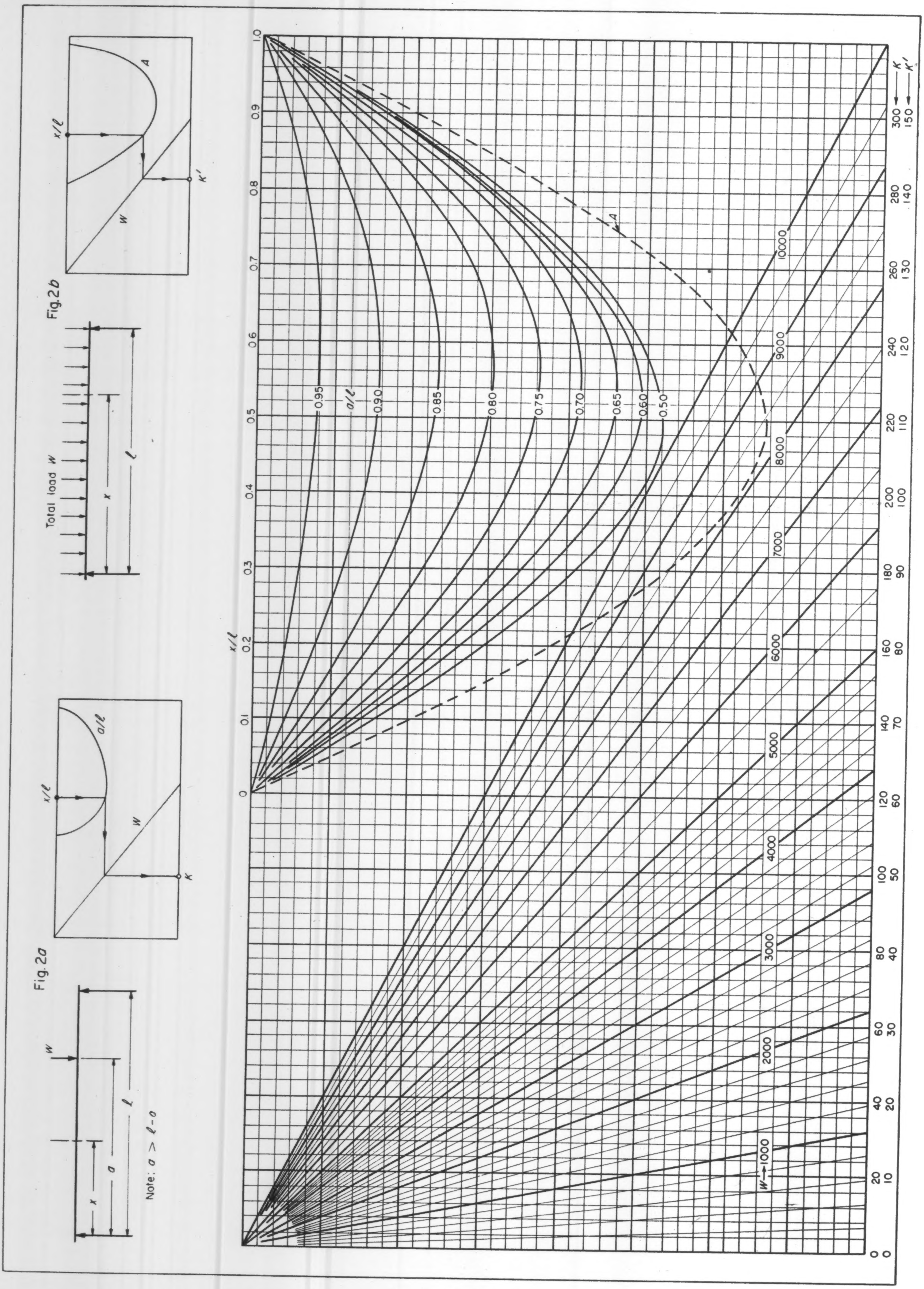


Fig. 2

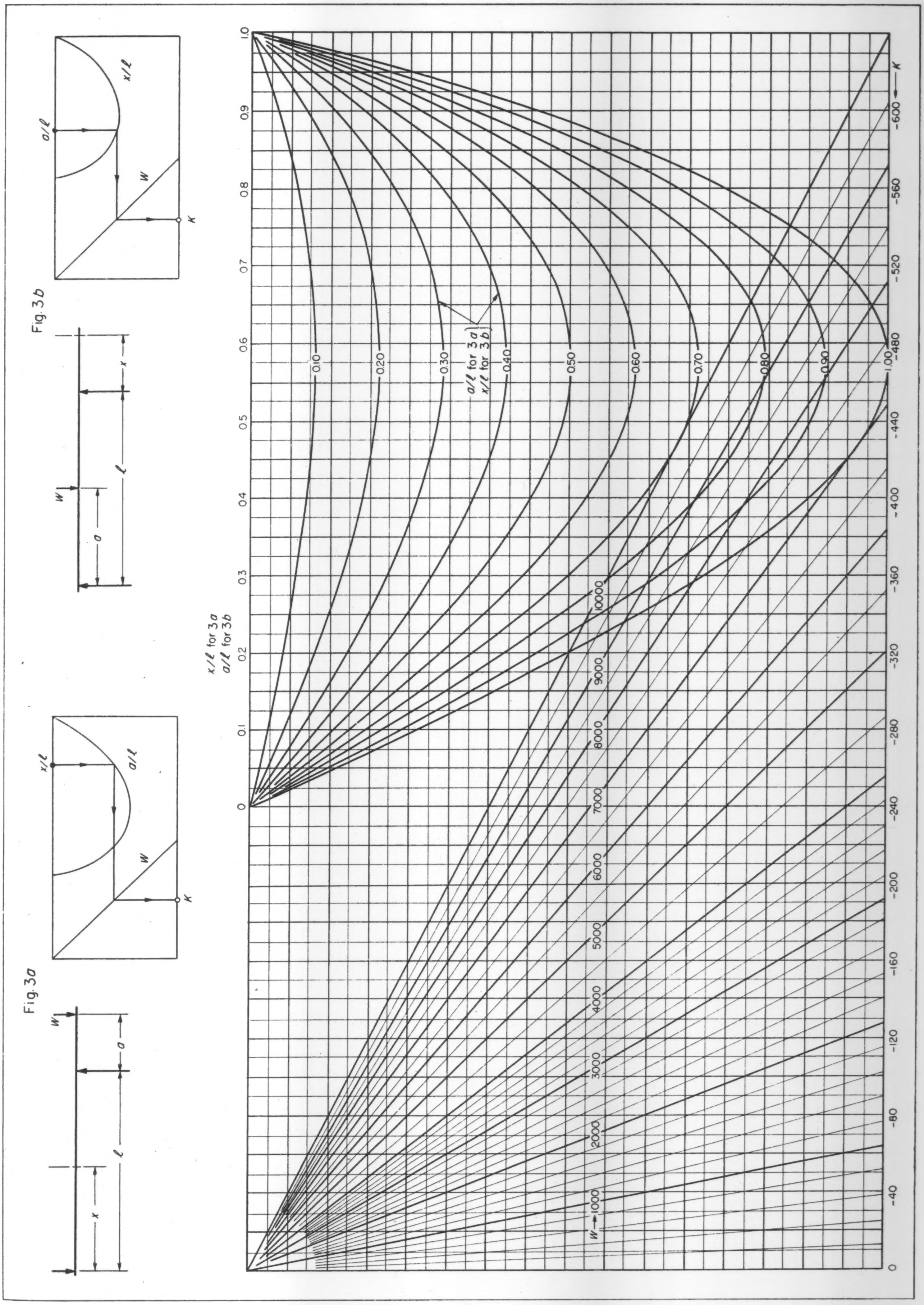


Fig. 3a
Fig. 3b
W
a
ℓ
x
x/ℓ
a/ℓ
K
x/ℓ for 3a
a/ℓ for 3b
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1.0
0.10
0.20
0.30
0.40
0.50
0.60
0.70
0.80
0.90
1.00
a/ℓ for 3a
x/ℓ for 3b
W→1000
2000
3000
4000
5000
6000
7000
8000
9000
10000
0
-40
-80
-120
-160
-200
-240
-280
-320
-360
-400
-440
-480
-520
-560
-600
K

Fig. 3

Data Sheet

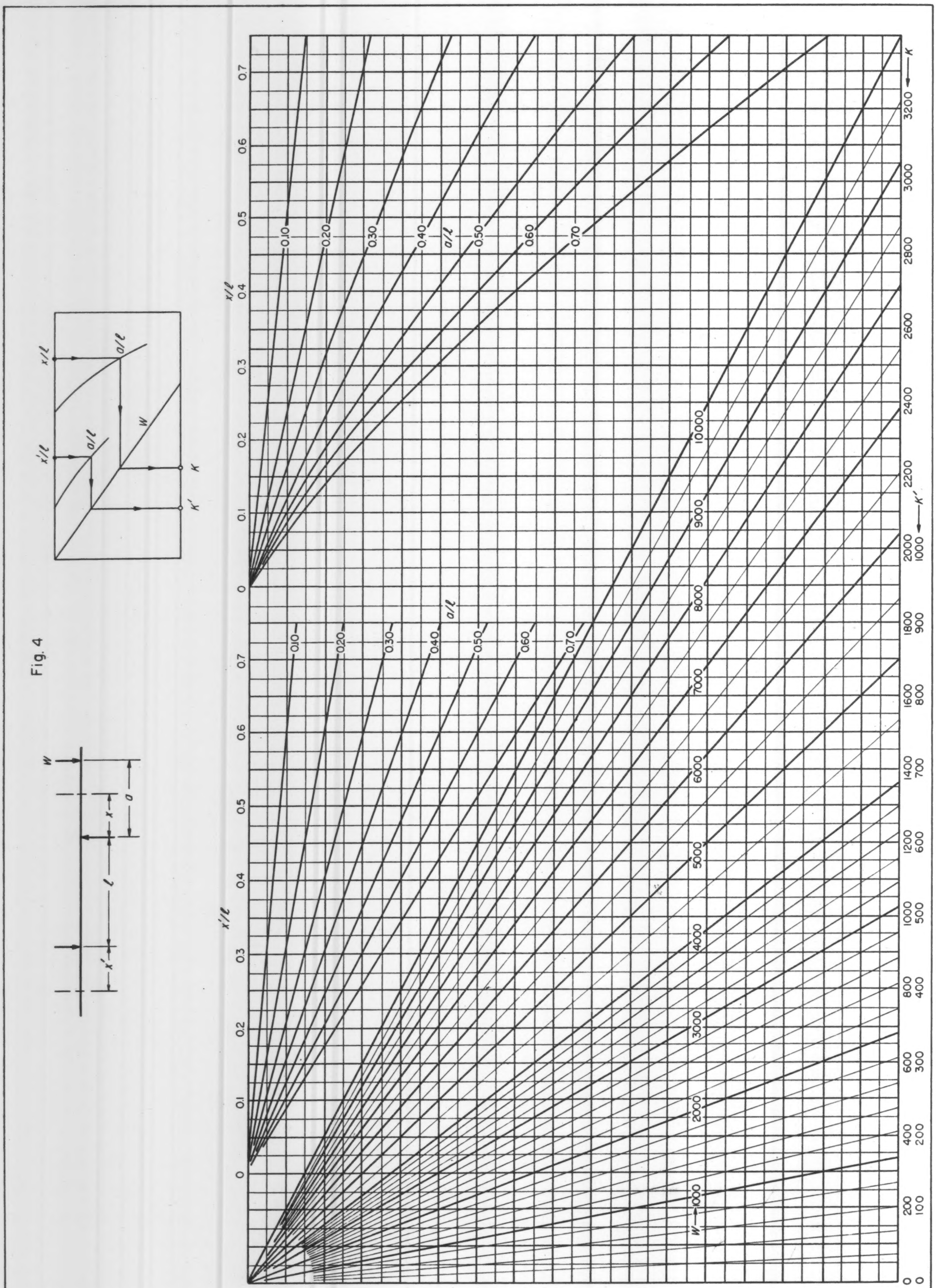


Fig. 4

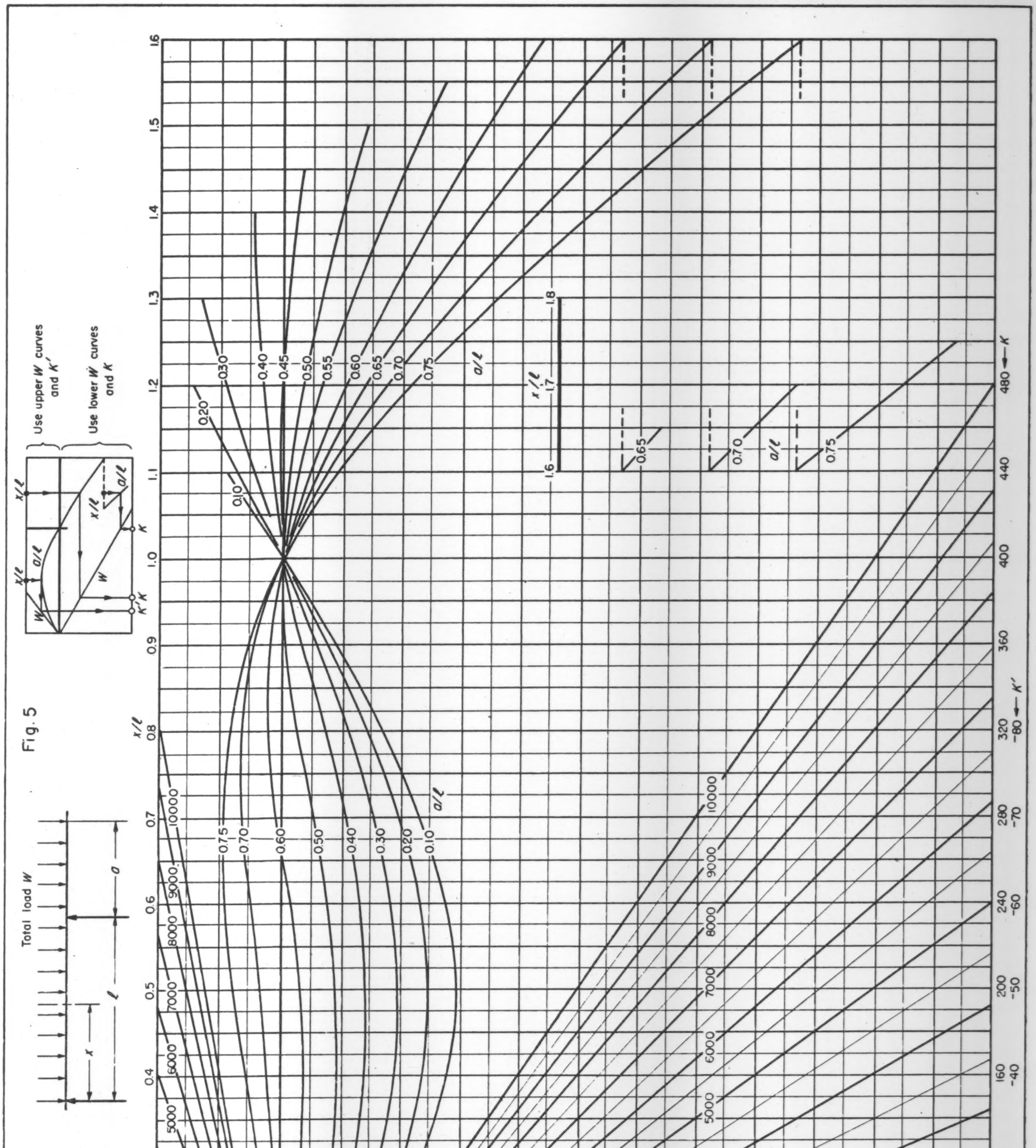


Fig. 5
Total load W
x
l
a
Use upper W curves and K'
Use lower W curves and K
x/l
a/l
W
K'
K
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1.0
1.1
1.2
1.3
1.4
1.5
1.6
0.10
0.20
0.30
0.40
0.45
0.50
0.55
0.60
0.65
0.70
0.75
0.75
0.70
0.60
0.50
0.40
0.30
0.20
0.10
a/l
1.6
1.7
1.8
W → 1000
2000
3000
4000
5000
6000
7000
8000
9000
10000
0 0
40 -10
80 -20
120 -30
160 -40
200 -50
240 -60
280 -70
320 -80
360
400
440
480 ← K
← K'

Fig 5

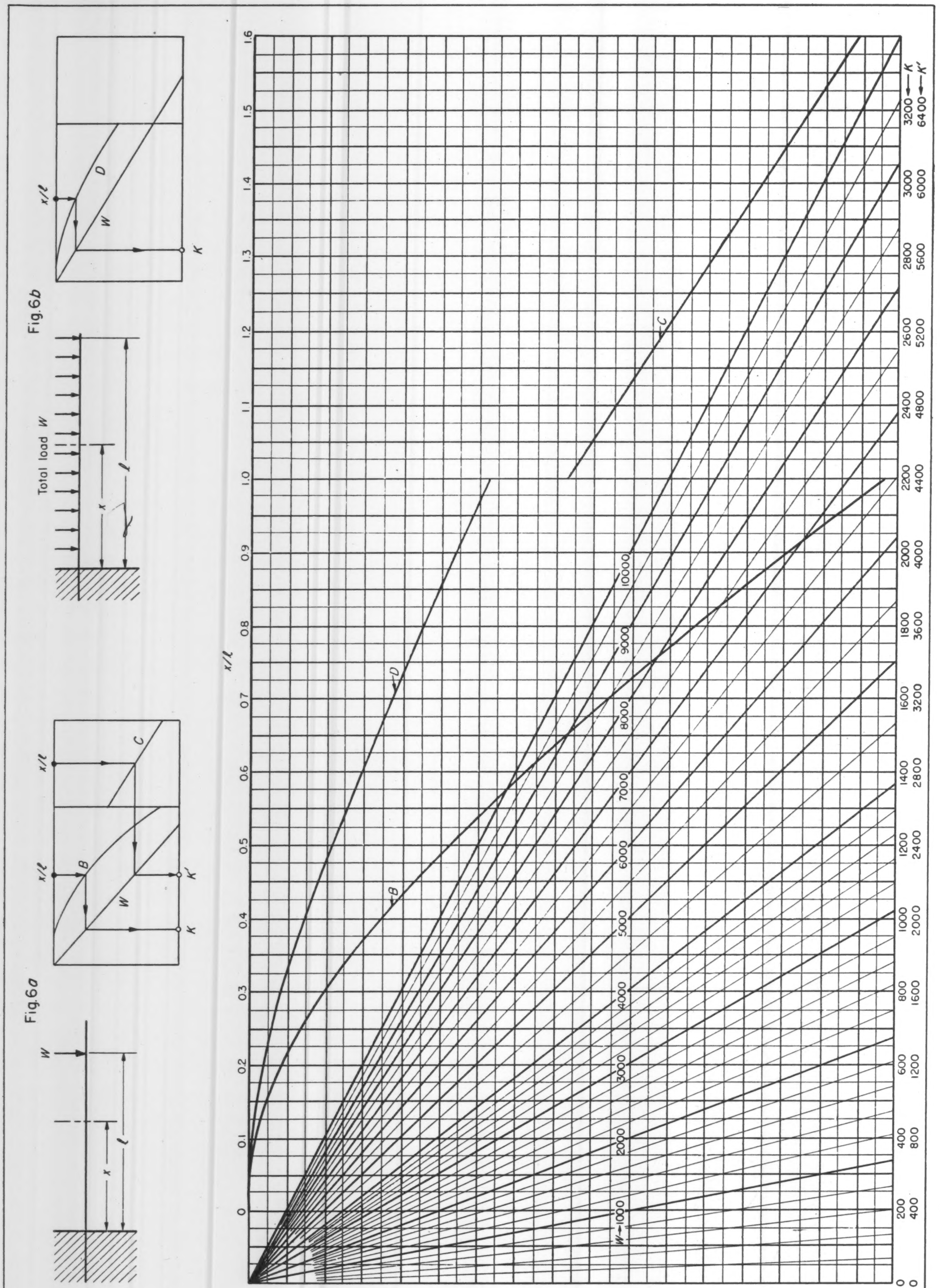


Fig. 6a
W
x
ℓ
x/ℓ
B
W
K
K'
C
Fig. 6b
Total load W
x
ℓ
x/ℓ
D
W
K
x/ℓ
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1.0
1.1
1.2
1.3
1.4
1.5
1.6
B
C
D
W→1000
2000
3000
4000
5000
6000
7000
8000
9000
10000
0 0
200 400
400 800
600 1200
800 1600
1000 2000
1200 2400
1400 2800
1600 3200
1800 3600
2000 4000
2200 4400
2400 4800
2600 5200
2800 5600
3000 6000
3200←K
6400←K'

Fig. 6

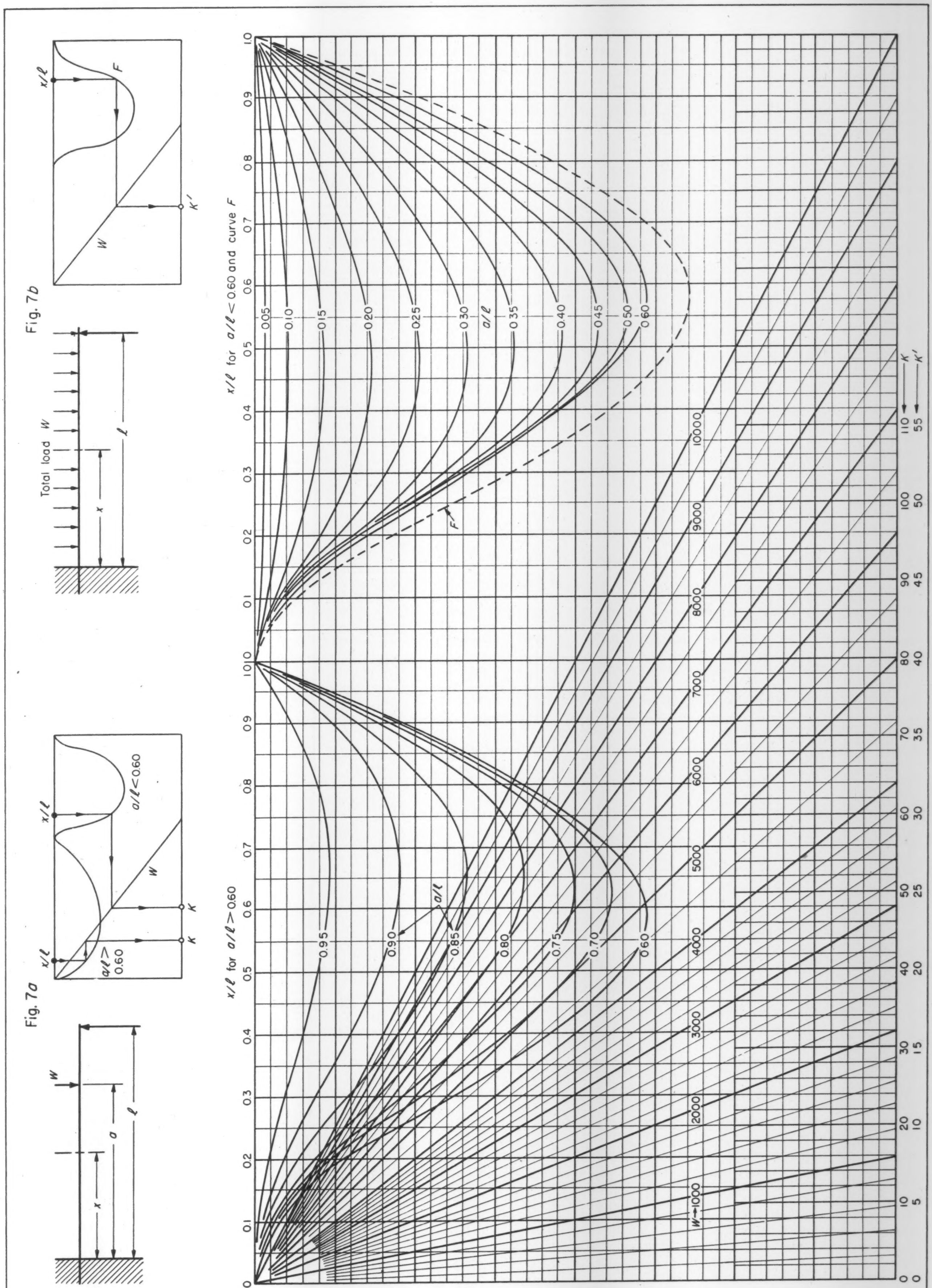
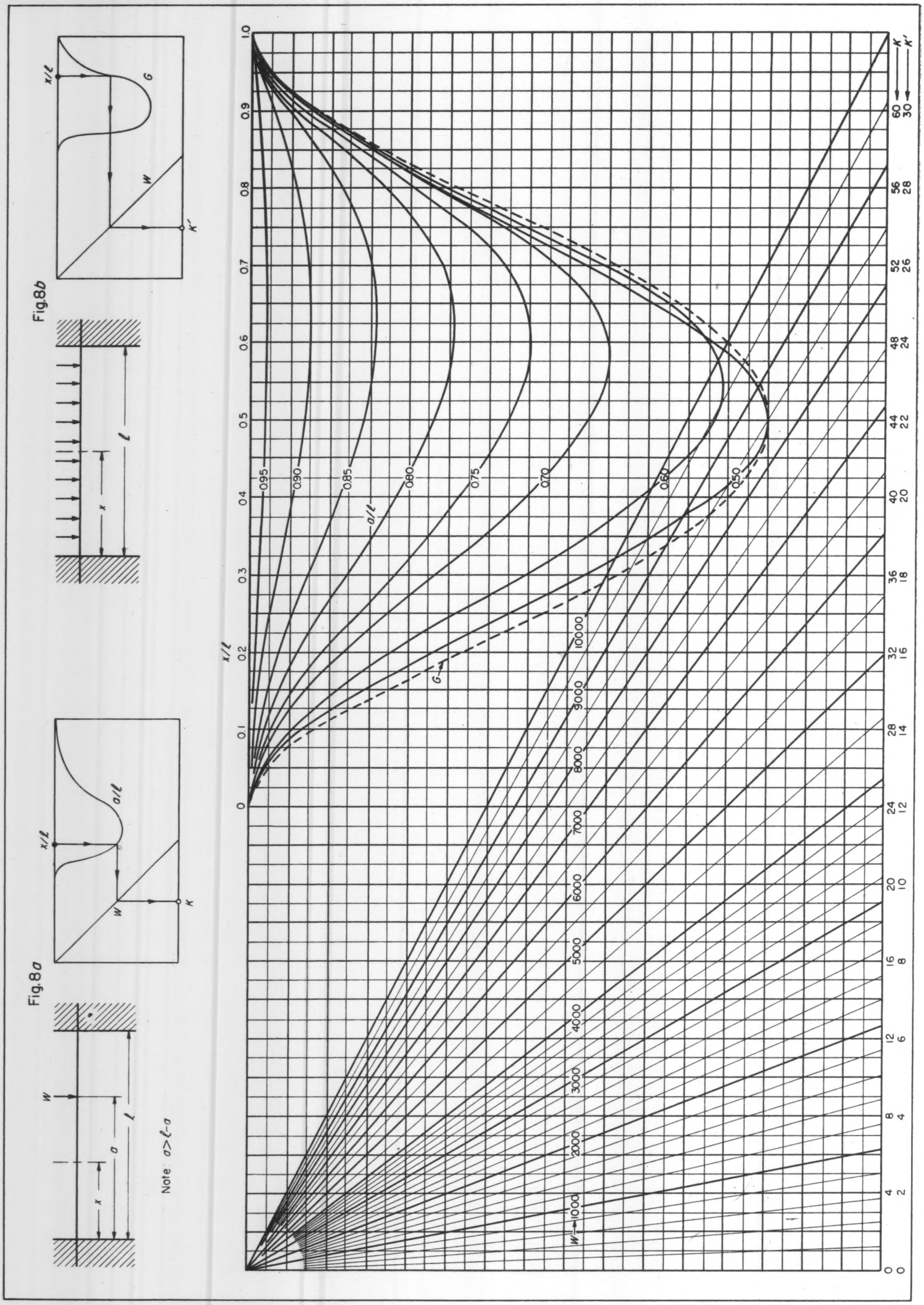


Fig. 7a
W
x
a
ℓ
x/ℓ
x/ℓ
a/ℓ > 0.60
a/ℓ < 0.60
W
K
K
Fig. 7b
Total load W
x
ℓ
x/ℓ
F
W
K′
x/ℓ for a/ℓ > 0.60
x/ℓ for a/ℓ < 0.60 and curve F
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1.0
0.95
0.90
0.85
0.80
0.75
0.70
0.60
a/ℓ
0.05
0.10
0.15
0.20
0.25
0.30
0.35
0.40
0.45
0.50
0.60
F
W→1000
2000
3000
4000
5000
6000
7000
8000
9000
10000
K
K′
0 0
10 5
20 10
30 15
40 20
50 25
60 30
70 35
80 40
90 45
100 50
110 55

Fig. 7



Note: $a > l - a$

Fig. 8

Beam Deflection

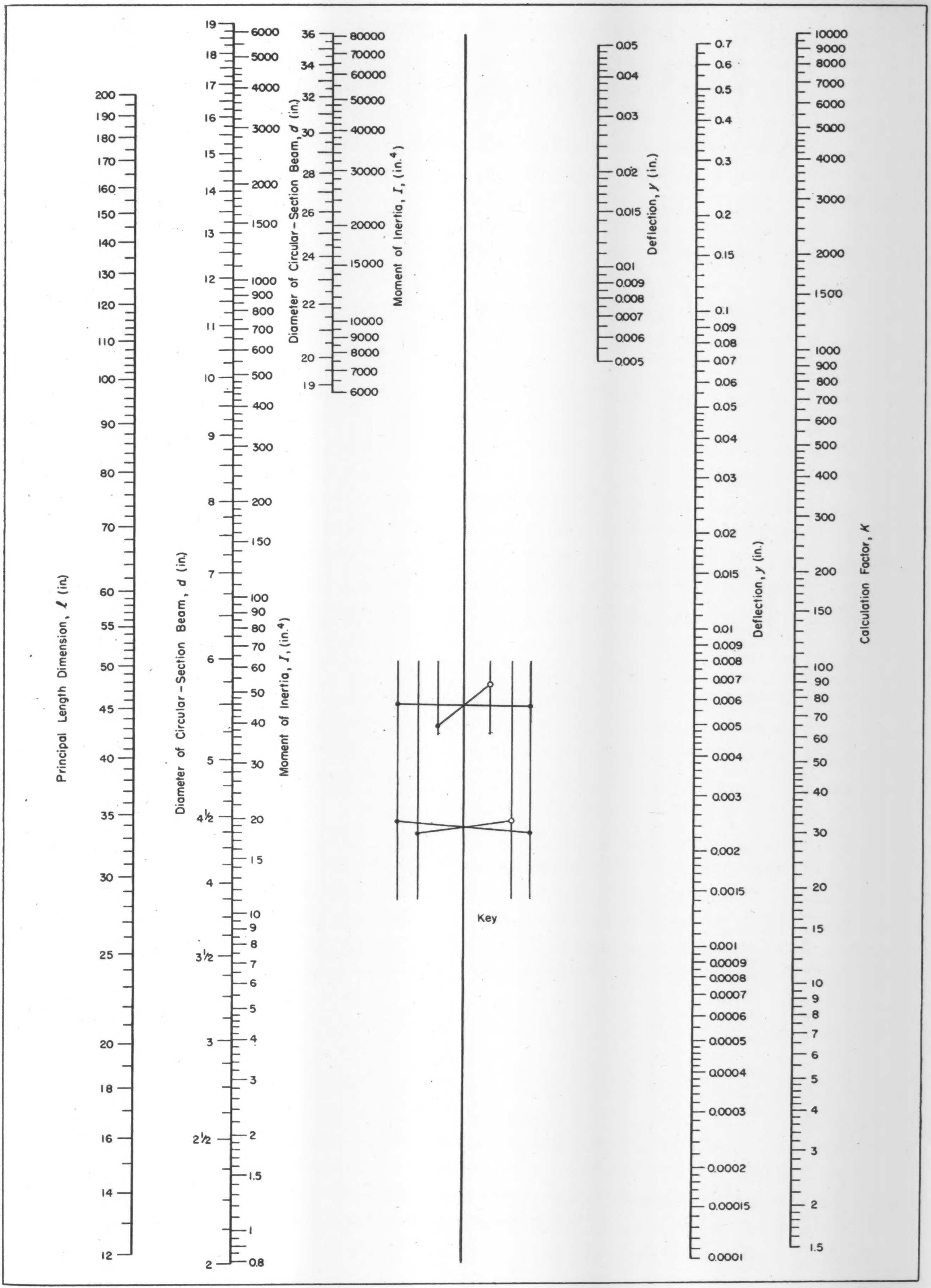


Fig. 9

DESIGN ABSTRACTS

Practical Dimensioning

By E. C. Helmke
Gisholt Machine Co.
Madison, Wis.

DIMENSIONING a drawing is at best an odious task. It requires intense attention to detail and always comes just after considerable time has been spent making a beautifully neat drawing of the part. Still, without dimensions a drawing is useless for most practical purposes. Since poor dimensioning practice can add tremendously to the cost of the product it seems worthwhile to point out what poor dimensioning is.

A large part of good dimensioning practice consists of avoiding the accumulation of tolerances. Other factors that make a difference between good and bad practice are the placement of dimensions, the selection of dimensions to insure certain shop procedure, and appreciation of the terms *clearance, tolerance* and *limits.*

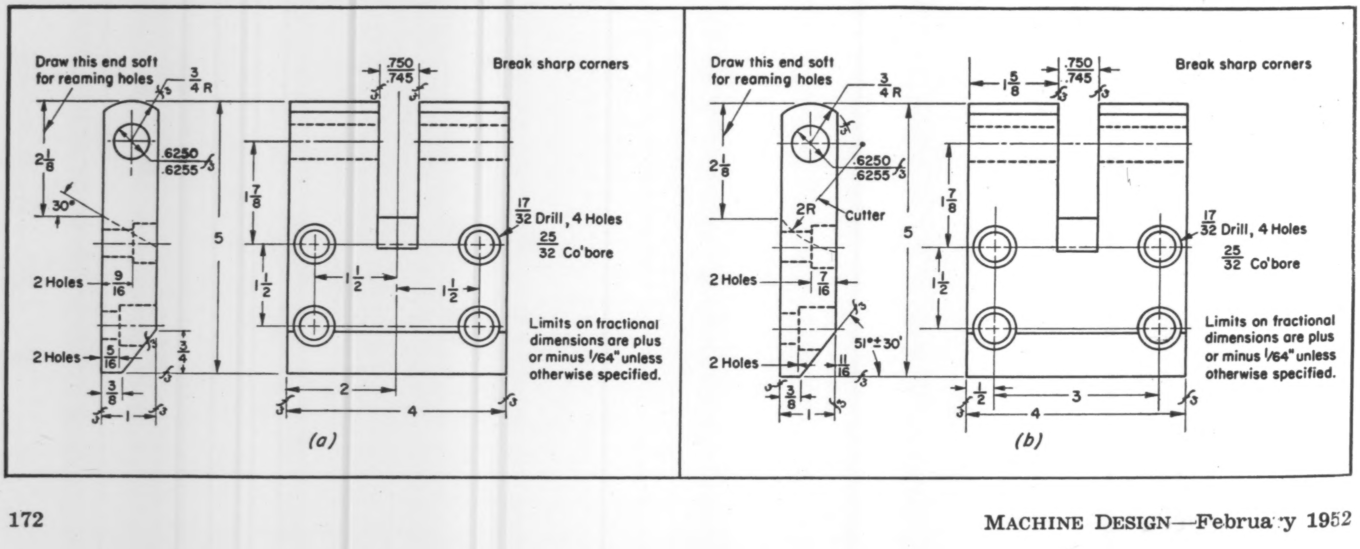
There are cases of absolutely absurd limits on drawings just because the draftsman or the young engineer had no conception of the meaning or the use of limits. It is essential that the young engineer be impressed with the fact that limits must be as broad as possible, and that four or more decimal places on a dimension are to be used sparingly and treated with respect when they do appear. He should have sufficient work with the limit tables so that he becomes thoroughly familiar with their use and does not guess at limits until he has piled up sufficient experience to make his guesses intelligent.

Accumulation of tolerances is of course the major fault with much dimensioning practice. This fact is so obvious it is usually assumed that the draftsman will carefully avoid accumulated tolerances. However, because it is so obvious a fault, it is one that is most frequently overlooked and results in more waste of material and time than all other dimensioning errors.

Shown in *Fig.* 1*a* are some common dimensioning errors. This is a stock block or support for a small air cylinder, and most of the machining is for appearance only. The angle at the lower end of the block is for clearance, and the slot in the upper half of the block supports the pivot point or clevis of the air cylinder. Since the parts are used in rather small quantities not much money can be spent for tooling.

With the method used for dimensioning the horizontal spacing of the bolt holes, a total variation of $\frac{1}{32}$-in. could result, completely taking up the clearance that was allowed by drilling the holes $\frac{1}{32}$-in. over size. When this practice is applied to both rows of holes where the total deviation might occur in opposite directions, it can readily be seen that the bolt holes may not mate with the previously drilled and tapped holes in the bed. Then, too, the method

Fig. 1—Common dimensioning errors in *(a)*, which permit tolerance accumulation and add to the cost, have been corrected in *(b)*


Draw this end soft for reaming holes
3/4 R
2 1/8
.6250
.6255
30°
5
1 7/8
1 1/2
.750
.745
Break sharp corners
17/32 Drill, 4 Holes
25/32 Co'bore
1 1/2
1 1/2
2 Holes
9/16
2 Holes
5/16
3/4
3/8
1
2
4
Limits on fractional dimensions are plus or minus 1/64" unless otherwise specified.
(a)
Draw this end soft for reaming holes
3/4 R
2 1/8
.6250
.6255
2R
Cutter
5
1 7/8
1 1/2
1 5/8
.750
.745
Break sharp corners
17/32 Drill, 4 Holes
25/32 Co'bore
2 Holes
7/16
2 Holes
11/16
51°±30'
3/8
1
1/2
3
4
Limits on fractional dimensions are plus or minus 1/64" unless otherwise specified.
(b)

used for dimensioning the depth of the counterbore for the bolt heads makes it necessary for the machinist to subtract dimensions which introduces a possible source of human error.

Also, the bottom of the ¾-in. wide slot is shown as a 30-deg angle which means that for machining of this angle, a complicated angular setup is required on the milling machine. The bottom of this slot, however, serves for clearance only, and could just as well have been dimensioned with a radius. Drawn in this manner, the block could have been held in a horizontal position in the milling machine vise.

With the clearance angle at the bottom of the block dimensioned as shown in ***Fig.* 1*a*,** the machinist must either calculate this angle or else arrive at the correct setting by cut and try.

In ***Fig.* 1*b*** these errors have been corrected, and the tolerance of the horizontal bolt hole spacing has been reduced from ±1/32-in. in ***Fig.* 1*a*** to ±1/64-in. In addition to showing a radius at the bottom of the slot, ***Fig.* 1*b*** shows how the position of the slot has been positively located. Also, an angle is specified for the clearance cut. As a result of these dimensioning changes, a better part can be produced at a lower cost.

There is one other change which could have been made in the design of this block to reduce its cost. Since this is merely a stock or support block, it is not essential that the block be exactly 1 in. thick and exactly 4 in. wide. The block would perform its function just as well if it were only ⅞-in. thick and 3⅞-in. wide. Then, the block could have been made from 1-in. by 4-in. steel instead of having to be made from 1¼-in. by 4¼-in. steel.

Frequently the equipment on hand determines how a part is to be dimensioned. A rack which was used in large quantities during the war on a special machine needed to be 107 in. long. However, since the only rack cutter available had a short table, it was necessary to make the racks in short lengths and to use them in multiple. Although this could be done, a dowel collar had to be provided for locating each section of rack securely and accurately. As a consequence, the bolt spacing dimensions were given as dimensions with no tolerances. Actually these figures were drill-jig dimensions. If it had been possible to make this rack in one piece, rather liberal limits could have been given for the bolt-hole spacing dimensions, since then only one locating dowel collar would have been required, and the problem of finish fitting the ends of the racks so as to get the correct tooth spacing would not have existed.

A common and dangerous dimensioning error is the "chain" dimensioning of bolt-hole locations for a series of bolt holes on the same centerline. The case shown in ***Fig.* 2*a*** is, of course, an extreme example, but it

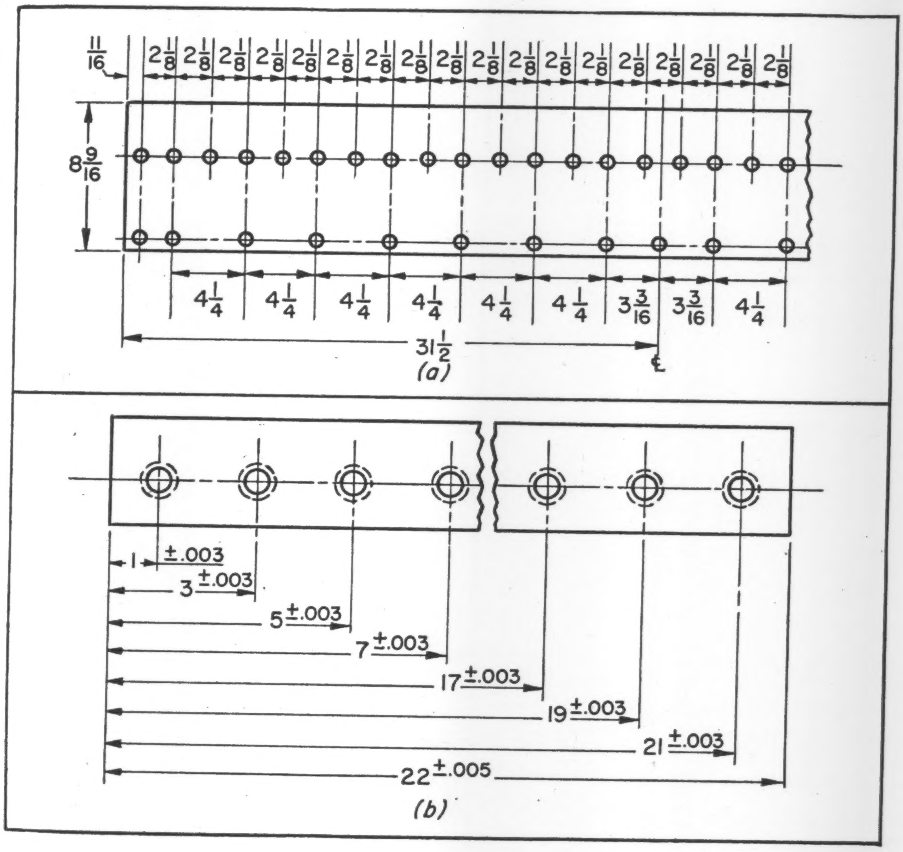
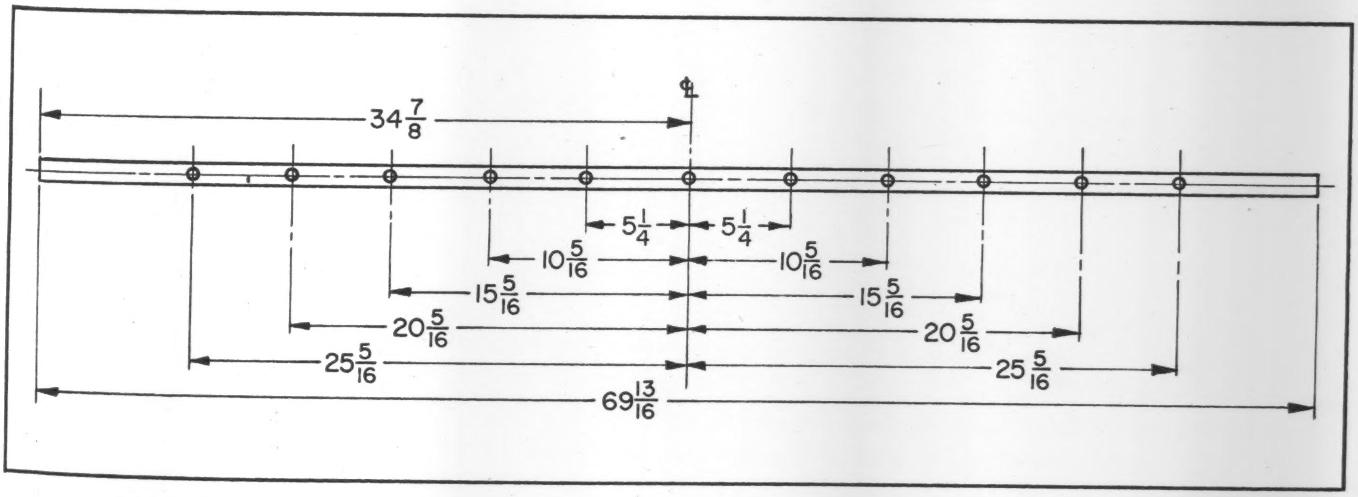


Fig. 2 — Left — Dangerous practice of "chain" dimensioning in *(a)* leads to excessive tolerance accumulation and shop errors. Better method is shown in *(b)*

Fig. 3—Below—This method of dimensioning assures accurate location of bolt holes symmetrical about a center line



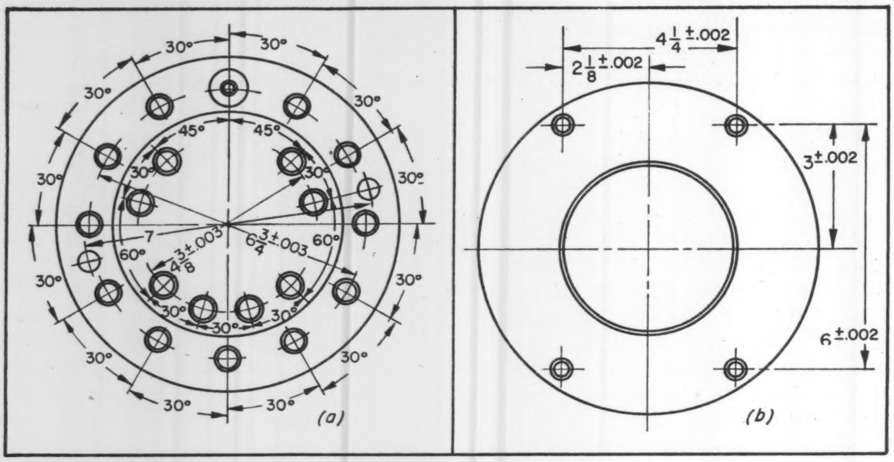
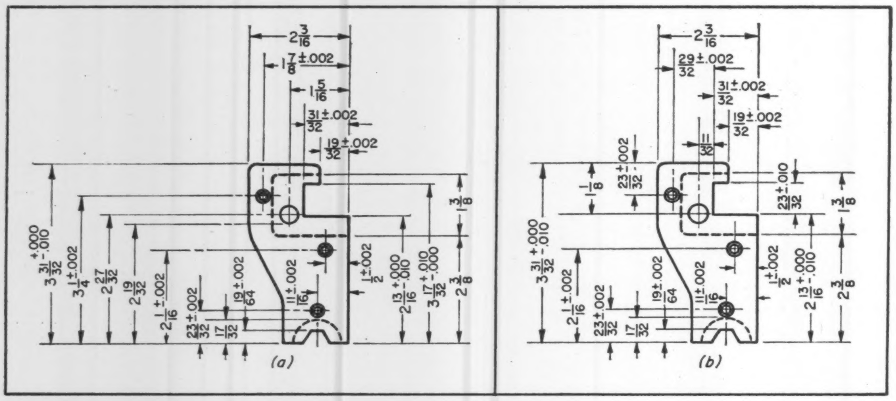


Fig. 4—Above—Angular method of bolt hole location shown in *(a)* is best superseded by co-ordinate or offset method in *(b)*

Fig. 5—Below—Good practice *(a)* contrasted with poor practice *(b)* emphasizes the importance of careful base line selection



actually did occur in the drawings of a press manufacturer. The danger of the accumulation of tolerances here is obvious. A workman laying out the holes in this part would, of course, first scribe the two horizontal centerlines. Then after establishing the first hole at 11/16-in. from the left-hand end, he would set his dividers for 2⅛ in. and step off the other spaces to locate the remaining holes on the upper centerline. If he missed the divider setting by only 0.005-in., the total cumulative error by the time the last hole was reached would amount to 0.145-in. (29 holes).

The method of dimensioning shown on *Fig.* 2*b* shows all bolt hole spacing dimensions given from the left-hand end of the part. No tolerances can accumulate and replacement parts can be made at any time.

Another example of good dimensioning practice is shown in *Fig.* 3. On this part it was essential that the tapped holes be accurately located from the vertical centerline of the shaft.

The dimensioning of bolt-hole locations when bolt holes appear in a circular pattern can be done in several ways. The older method consisted of giving the diameter of the bolt circle, and then giving the angular spacing between bolt holes as shown in *Fig.* 4*a*. This method is simple and rapid for the draftsman, but it presents problems to the shop man who must make angular measurements and accurately transfer them to the workpiece. These difficulties are overcome by the co-ordinate or offset method illustrated in *Fig.* 4*b*. Here all bolt hole locations are given in two dimensions, one from the vertical centerline and the other from the horizontal centerline of the part. Consequently the bolt holes are easy to locate accurately, especially if a jig borer is available.

Another dimensioning "must" that is frequently overlooked is the proper choice of a base line or lines from which various dimensions are given. *Fig.* 5*a* is a good example of well-chosen base lines. In spite of rather broad tolerances, the actual location of critical surfaces and holes are held to reasonably close limits.

In *Fig.* 5*b* this latch has been redimensioned to typify a poor practice. Several of the dimensions have been taken from other base points although the original drawing limits have been retained. It is obvious that a part made from the drawing in *Fig.* 5*b* would not be nearly as accurate as one made from *Fig.* 5*a*. At first glance this example appears exaggerated. However, the tracing vaults of industry contain thousands of drawings with this same failing of multiple reference lines.

These are some of the simple principles of practical dimensioning that are well known but frequently overlooked. In summary, avoid tolerance accumulation, place dimensions in reference to the best base line, and dimension to insure certain manufacturing procedures.

From a paper of the same title presented at the Annual Meeting of the ASEE in East Lansing, Mich., June 25-29, 1951. *Annotated booklet of drawings used in the paper may be obtained from Gisholt Machine Co., Dept. MB,* 1245 *E. Washington Ave., Madison* 10, *Wis.; no charge for single copies, nominal charge for multiple copies.*

Inelastic Properties of Metals

By W. P. Welch and B. Cametti
Westinghouse Electric Corp.
East Pittsburgh, Pa.

ELASTIC hysteresis is now the well-accepted term describing inelastic effects at stresses below the conventional elastic limit. In the design of torque-weighing devices, an important practical problem is the selection of a shaft material having low hysteresis and creep.

Although hysteresis is a primary cause of error, creep at the ambient temperature may be sufficiently large

(Continued on Page 236)

NEW PARTS AND MATERIALS

. . . presented in quick-reference data sheet form for the convenience of the reader. For additional information on these new developments, see Page 191

MINIATURE RELAY 1

. . . for acceleration and vibration conditions

North Electric Mfg. Co., 3400 *Market St., Galion, O.*

This relay is claimed to be the smallest of all subminiature relays with comparable power.

Designation: PHG.

Size: ⅞ x ⅞ x ⅞-in.; header, 0.600-in. OD; two 4-40 thread mounting bolts.

Service: Operates normally under 50g acceleration, 0.06-in. vibration at 60 cycles per sec; 25 gm contact pressure; various electrical characteristics available.

Design: Double-pole, double-throw; balanced-armature relay is sealed in drawn aluminum can; hermetically sealed with dry-air fill, or vacuum-pumped and pressure-filled with dry nitrogen; 8 terminals.

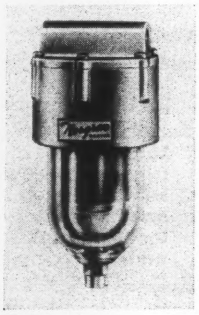
For more data circle MD 1, Page 191

FILTER-DRAIN 2

. . . removes liquids and solids from air lines

C. A. Norgren Co., Englewood, Colo.

For use where manual draining is not practical, these units operate even when flow of air is cut off.



Size: For ¼, ⅜ and ½-in. pipe.

Service: Automatic filtering, removal of solids and liquids, and drainage of collected liquids from compressed air lines; operates under constant or fluctuating pressure and flow; low pressure drop; 0 to 35 cfm flow at 0 to 150 psi pressures, 40 to 120 F temperatures.

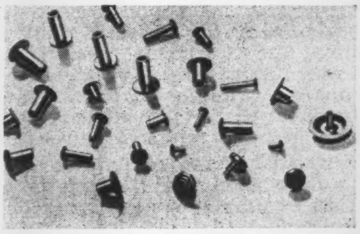
Design: In-line threaded pipe connections; filter is placed in line before drain chamber, preventing sludge or solid particles from clogging the drain or causing drain float to stick.

For more data circle MD 2, Page 191

ZINC-ALLOY RIVETS 3

. . . die-cast to close tolerances

Gries Reproducer Corp., 780 *E.* 133*rd St., New York* 54, *N. Y.*



Low in cost, these tubular rivets are well-suited to low-stress applications.

Size: 1/16 to 9/64-in. diam; lengths to 5/16-in.

Service: Riveting, with tensile strength of 45,000 psi; rustproof and corrosion-resistant; close tolerances; high uniformity; machine or hand application.

Design: Tubular or semitubular; oval or flat countersunk heads; specials include very small sizes, ornamented head designs, and extra large head diameters; die-cast from zinc alloy; plain, bright or various commercial finishes.

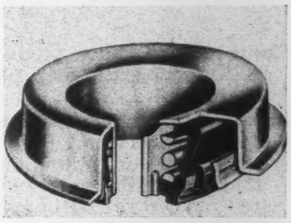
For more data circle MD 3, Page 191

MECHANICAL SEAL 4

. . . for high shaft speeds or vibration

Crane Packing Co., 1800 *Cuyler Ave., Chicago* 13, *Ill.*

Retainer does not contact the shaft, and sealing unit does not revolve with the shaft, so that high speeds and vibration conditions can be accommodated easily.



Designation: 11A.

Size: For shaft sizes of ⅜ through ⅝-in.

Service: Shaft sealing at speeds of 6000 rpm and over, vibration conditions can be accommodated; pressures to 50 psi; temperature to 212 F; rubber flexing member encloses and protects spring from corrosive liquids.

Design: Synthetic rubber flexing and sealing members are held stationary by metal retainer, eliminating stress on the flexible bellows.

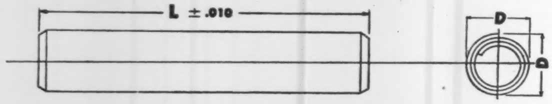
For more data circle MD 4, Page 191

NEW PARTS AND MATERIALS

PIN FASTENERS 5

. . . of flexible coiled strip steel

C.E.M. Co., 24 School St., Danielson, Conn.



Properties of this coiled-spring, spiral cross-section pin can be changed by varying strip thickness, tightness of coils, and number of coils in the spiral.

Designation: Spirol.

Size: Heavy-duty and medium duty—⅜-in. length by $\frac{1}{16}$ and $\frac{5}{64}$-in. diam—½ and ⅝-in. lengths by $\frac{1}{16}$, $\frac{5}{64}$, $\frac{3}{32}$, $\frac{7}{64}$, ⅛ and $\frac{5}{32}$-in. diam—¾, ⅞ and 1-in. lengths by same diam plus $\frac{3}{16}$, $\frac{7}{32}$ and ¼-in. diam—1¼ and 1½ in. lengths by $\frac{7}{64}$ through ¼-in. diam—1¾ and 2 in. lengths by $\frac{5}{32}$ through ¼ in. diam—2¼ and 2½ in. lengths by ¼-in. diam; light-duty—same, except $\frac{1}{16}$ and $\frac{5}{64}$-in. diam not available.

Service: Heavy-duty for applications requiring shear strength up to 25% higher than solid pin of same diam; medium-duty for shear strength approximately 20% lower; light-duty for noncritical applications or fastening unlike materials; spring action locks pin in position throughout length; resist shock and vibration; can be removed or reassembled.

Design: Strip steel rolled to spiral coil, then heat-treated; stainless steel, brass, aluminum or other flexible materials available; one or both ends chamfered; will fit taper pin hole.

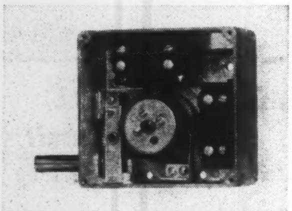
For more data circle MD 5, Page 191

LIMIT SWITCH 6

. . . operates from rotating drive-shaft

General Electric Co., Control Dept., Schenectady 5, N.Y.

Switch action is co-ordinated with number of revolutions of a reversing shaft.



Size: 4$\frac{27}{32}$ in. long plus 1½ in. shaft extension; 4$\frac{11}{32}$ in. high; 2$\frac{3}{32}$ in. deep; ½-in. diam shaft; ¾-in. pipe tap conduit.

Service: Controlling reversing and travel-limit operations; contact units operate between minimum of 4 turns and maximum of 110 turns of shaft, adjustable; 5 turns overtravel in either direction; unlimited overtravel without damaging switch; maximum "make" current, 50 amp, a-c or d-c; recommended interrupting capacity (d-c inductive circuit), 0.0-amp at 115 v, 0.25-amp at 230 v, 0.14-amp at 550 v; same (a-c circuits), 25 amp at 110-220 v, 7.5 amp at 440-550 v.

Design: Two size 2 Switchettes, each having one normally-open and one normally-closed circuit, are operated independently by two single-point cams; cams can be angularly adjusted with respect to each other; cam assembly is rotated through worm and gear reduction by shaft extending outside of zinc die-cast case; watertight and explosionproof cast-iron cases available; foot bracket available.

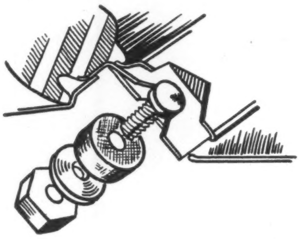
For more data circle MD 6, Page 191

SEALING WASHER 7

. . . flows into space around bolts

Presstite Engineering Co., 39th & Chouteau Aves., St. Louis 10, Mo.

Effecting a tight seal between bolt and hole rim, this sealer requires only a minimum of bolt pressure to make it flow into voids and openings.



Size: Thickness, $\frac{1}{16}$ or ⅛-in.;

ID* (in.)	OD (in.)	ID* (in.)	OD (in.)
⅛	½	$\frac{5}{16}$	$\frac{11}{16}$
$\frac{3}{16}$	$\frac{9}{16}$	⅜	¾
¼	⅝	$\frac{7}{16}$	⅞

*Specifies bolt size.

Service: Sealing around bolts, screws, fasteners, and clips; adheres strongly to fraying surfaces; eliminates squeaks and rattles.

Design: Round semisolid washers made of different compounds; No. 169 for air, dirt, water and water-vapor; No. 155 is nonstaining and resistant to temperatures up to 375 F; No. 590.5 resists gasoline, oil and grease, and adheres to metal, plastics and other hard surfaces; light tissue-paper face prevents washer from sticking until pressure causes compound to flow through paper.

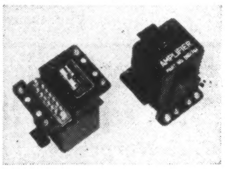
For more data circle MD 7, Page 191

SERVO AMPLIFIERS 8

. . . hermetically sealed and oil-filled

Servomechanisms Inc., Post and Stewart Aves., Westbury L. I., N. Y.

New packaging design provides for greater heat dissipation and elimination of hot spots, longer tube life, greater resistance to vibration and shock, and saving in space.



Designation: SA104H, SA112H.

Size: SA104H, 3¾ in. long, 2⅞ in. wide, 4$\frac{9}{16}$ in. high, weight, 2⅞ lb; SA112H, 3 in. long, 2¼ in. wide, 4⅛ in. high, weight, 1½ lb.

Service: For controlling 400-cycle, 2-phase servo motors; SA104H supplies 9 w at 115 v for high-performance servo loops and incorporates a derivative control network; SA112H supplies 3 w at 30 v to analog-computer servo loops, and is designed for velocity damping furnished by a tachometer generator; ambient temperatures, −65 to +175 F; altitude, 60,000 ft; meet requirements of USAF Spec. AN-E-19; SA104H has approximately linear speed-torque characteristics with typical motor, ranging from 2.0 oz-in. at 0 rpm to 0 oz-in. at 5300 rpm; SA112H characteristics are linear, ranging from 0.3 oz-in. at 0 rpm to 0 oz-in. at 6600 rpm; replaceable.

Design: Amplifiers are hermetically sealed and in oil-filled cases; power supplies can be furnished; mating receptacle or connector furnished; installed with four AN size 2 fasteners.

For more data circle MD 8, Page 191

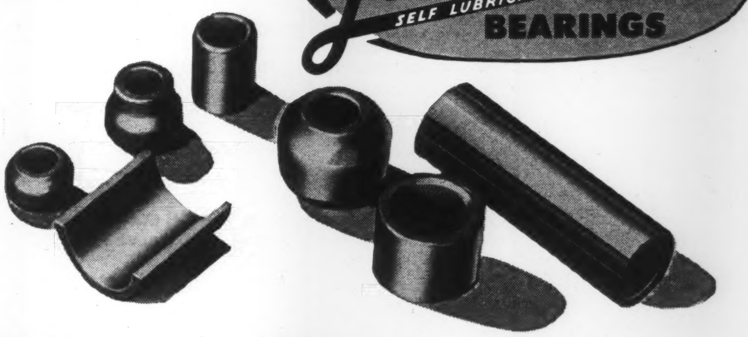
JOHNSON BRONZE

SLEEVE BEARING DATA

Ledaloyl SELF LUBRICATING BEARINGS

JOHNSON BRONZE

SLEEVE BEARING DATA

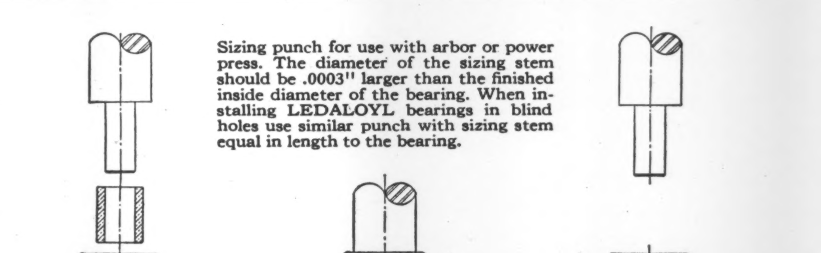


POWDER METALLURGY for Bearings and Parts

Powder Metallurgy is not a new manufacturing process . . . but its wide-spread adoption by industry is of comparatively recent origin. Bearings and parts, when produced by this method, are molded under pressure to required shape and size. This eliminates expensive machining operations and when quantities of a size are used the cost is surprisingly low. The original formula of the bronze powder consisted of approximately 88½ copper, 10 tin and 1½ graphite. In 1936, Johnson Bronze introduced LEDALOYL . . . a powder metallurgical product that **combined copper, tin, graphite and** *LEAD* in the form of a PRE-ALLOYED bearing bronze. The introduction of lead as an integral part of the bronze powder provided additional bearing qualities not possible otherwise.

Manufacturers of many types of equipment gain many **extra** advantages through the use of Johnson LEDALOYL. One valuable feature is the self-lubricating action. Myriads of tiny, evenly spaced pores serve as miniature oil wells. When the bearing is in use the oil is metered to the shaft . . . when at rest, the oil is absorbed by these pores. This provides adequate lubrication at all times . . . preventing wear and in most cases eliminating the expense and bulk of other lubrication aids. Service records show long, troublefree operation on many types of installations.

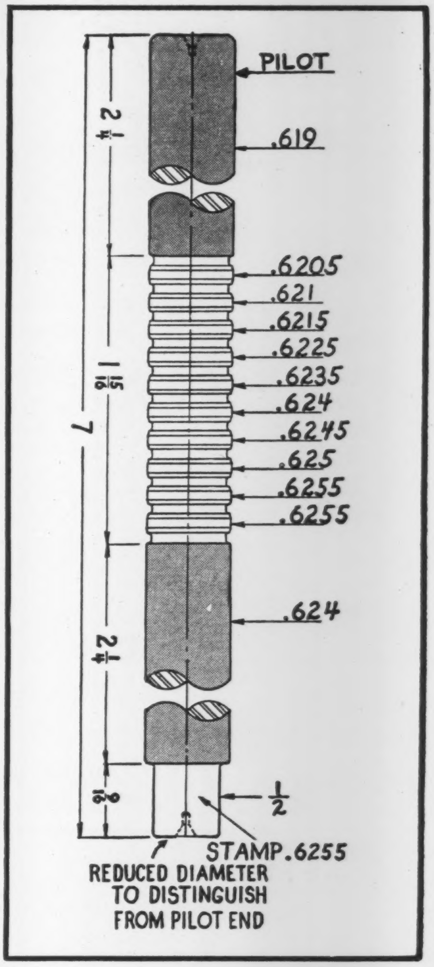
●



Sizing punch for use with arbor or power press. The diameter of the sizing stem should be .0003" larger than the finished inside diameter of the bearing. When installing LEDALOYL bearings in blind holes use similar punch with sizing stem equal in length to the bearing.

Method of Installations

LEDALOYL Bearings, correctly designed and properly installed, will usually outlast the motive unit in which they are used. We cannot place too much emphasis on installation. Absolute alignment is necessary in order to gain a low operating temperature, a short running-in period and a conservation of lubricant. The usual method of installing LEDALOYL is illustrated above. If your application is not covered in this way, we ask that you consult with our engineers. A method suitable to your application will be worked out. If your bearings are subject to excessive temperature during installation—such as in die cast applications—it is usually advisable to withhold impregnating the bearing until after assembly.



Typical Burnishing Tool

Harden, Grind and Lap, or Polish with Crocus Cloth High Speed Steel—Rockwell C-60-62.

Economy

The economy of using LEDALOYL is best illustrated in producing parts other than cylindrical in shape. Flat surfaces—flanges, offsets, etc. are easily provided for in the dies and no additional machining is necessary. Johnson engineers are always available to discuss the advisability of using LEDALOYL . . . or any other type of sleeve bearing in your product. Your inquiry carries no obligation.

●

This bearing data sheet is but one of a series. You can get the complete set by writing to—

Johnson Bronze

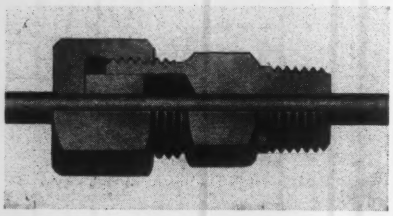
SLEEVE BEARING HEADQUARTERS
525 S. MILL ST. • NEW CASTLE, PENNA.

NEW PARTS AND MATERIALS

PACKING GLANDS 9

. . . of stainless-steel construction

Conax Corp., 4515 *Main St., Buffalo* 21, *N. Y.*



Two of the three models available may be used as small stuffing boxes for moving parts, or as static seals for small tubes.

Designation: PG-2, -3, -4.

Size: For rods or tubes with ⅛ to 13/32-in. OD (⅛-in. IPS); to ¾-in. OD available in near future; gland ID bored to specifications.

Service: PG-2 and PG-4 as stuffing boxes or static seals; PG-3 as static seal (pressure or vacuum) at temperatures exceeding 1400 F.

Design: Type 303 stainless-steel body; PG-2 and -4 have asbestos-graphite packing; PG-3 has powdered talc; plastic or other packing material may be used in place of material furnished.

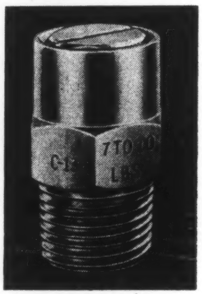
For more data circle MD 9, Page 191

RELIEF VALVE 11

. . . for low-pressure pneumatic applications

Andrews-Alderfer Co., 1090 *Home Ave., Bedford, O.*

Pressure of gas or vapor is controlled by presetting this valve in a 3-psi range.



Designation: Andal C-13.

Size: Length, 1 5/16 in., specials available; diam, ¾-in.; ¼, ⅜-in. or special pipe thread.

Service: Controlling pressure of gases or vapors in range from 7 to 10 psi; relief pressure preset with adjusting screw; recommended for rigid containers; withstands effects of weather: meets government salt-spray test requirements.

Design: Brass, steel, stainless steel or special-material body with adjusting screw; special pipe threads, or gasket and nut mounting available.

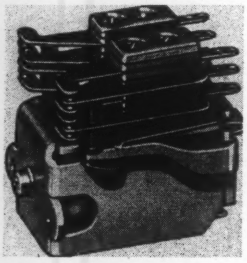
For more data circle MD 11, Page 191

SMALL RELAY 10

. . . sensitive to low-power actuating current

C. P. Clare & Co., 4719 *W. Sunnyside Ave., Chicago* 30, *Ill.*

High sensitivity results from a close-coupled magnetic circuit and efficient coil design.



Designation: Type N.

Size: 1⅝ in. long, 1 5/32 in. wide, 1⅝ in. high with 10 contact springs.

Service: Relay operation on less than 50 milliwatt with 10,000-ohm coil, one single-pole double-throw contact and a standard adjustment; operates on 0.7-watt with 450-ohm coil and one 4-pole double-throw set of contacts; sensitivity maintained under vibration and high ambient-temperature conditions; contact pressure, 30 gm minimum.

Design: Up to 10 contact springs can be assembled; relays with not more than 14 terminals (both coil and contact springs) can be hermetically sealed in small-size enclosure; contact gap, 0.015-in. minimum.

For more data circle MD 10, Page 191

LEAD-CLAD METALS 12

. . . combine acid resistance and strength

Knapp Mills Inc., 23-15 *Borden Ave., Long Island City, N. Y.*

A nonporous, chemically bonded lead cladding is applied to steel or copper, so that acid resistance of lead is combined with strength of steel or good electrical conductivity of copper.

Designation: Ferrolum, Cupralum.

Form: Ferrolum (lead-clad steel) as plates, heads, rods, bars, strips, angles, channels; Cupralum (lead-clad copper) as tubing, pipe, rods, bars, strips.

Size: Lead thickness—3/32, ⅛, 3/16, ¼, ⅜ or ½-in.; Cupralum tubing in ¾ or ⅞, 1 or 1⅛, 1¼ or 1⅜, 1½ or 1⅝, or 2 or 2⅛ in. OD.

Service: Resists sulphuric acid (85% concentration at 428 F) and other acids; temperatures to 500 F; pressures to 200 psi; withstands full vacuum; withstands frequent temperature cycles and vibration; good heat-transfer qualities.

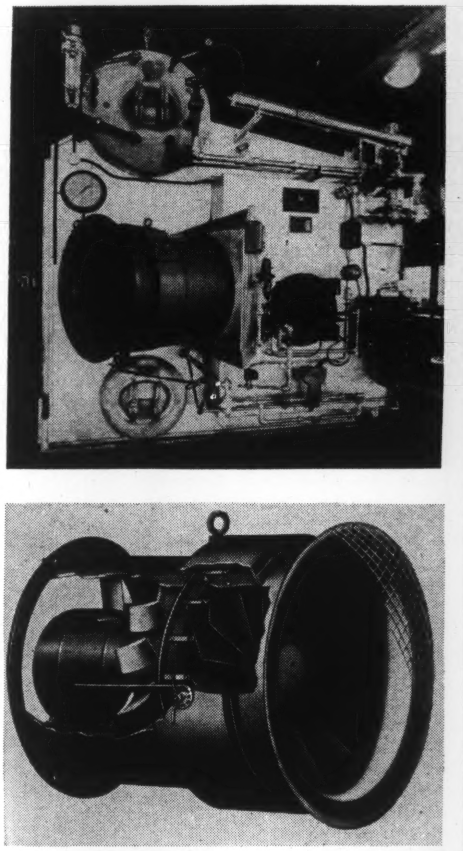
Properties: Carbon steel or soft-annealed deoxidized copper tubing is chemically bonded without tin to chemical or acid lead in accordance with ASTM designation B29-43; lead structure is dense, free of pinholes, porosity or laminations.

For more data circle MD 12, Page 191

ADVERTISEMENT

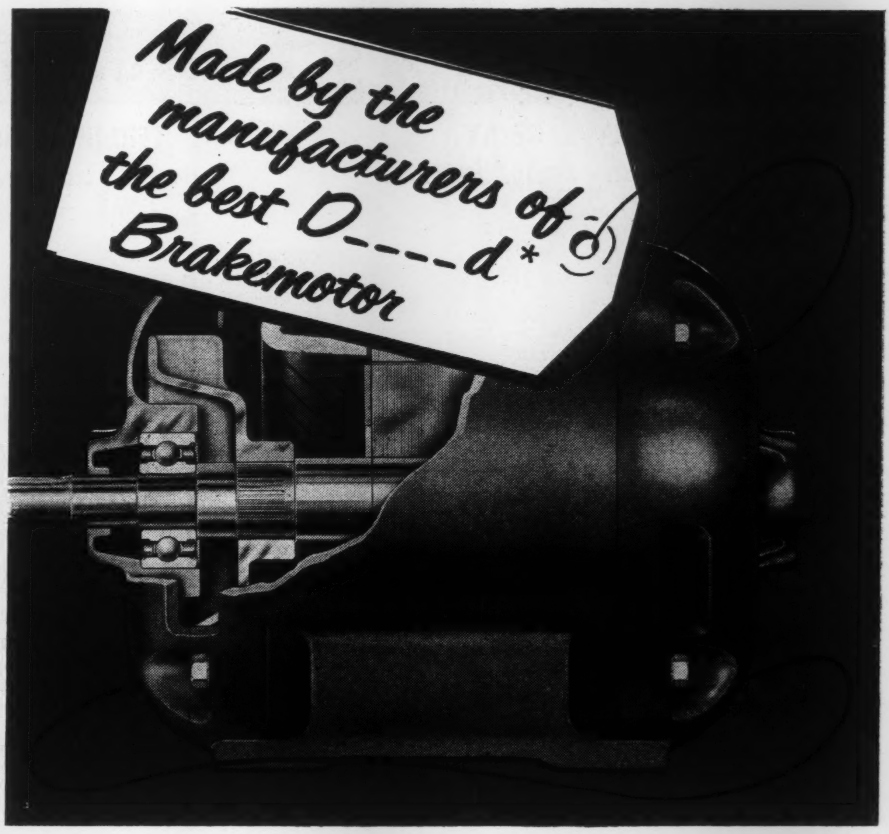
TOTALLY ENCLOSED MOTOR COOLED BY AXIAL AIR FLOW

In the type EMD Forced Draft Blowers built by L. J. Wing Manufacturing Company, Linden, New Jersey, a highly efficient means for cooling the driving motor is provided. Since these Wing blowers are so extensively used by leading manufacturers of equipment designed for combustion applications, totally-enclosed dust-tight motors are required. Axial flow fan wheels mounted directly on the motor shafts provide air-over-motor cooling.



Typical installation of an L. J. Wing blower on a Foster Wheeler unit. (Bottom) Cutaway view of blower shows totally-enclosed motor and the axial flow airfoil fan wheel for air-over-motor cooling.

The motor used is a 5hp, 60 cycle, 3 phase, 220/440 volt, 1740 rpm unit of the squirrel-cage type, designed by Star-Kimble, which has been supplying motors to L. J. Wing for over 25 years. Prelubricated bearings and extra insulation—standard features of Star-Kimble squirrel-cage motors—are of special importance in long motor life with little maintenance attention in hot, dusty locations. Another advantage, resulting from recent redesign of Star - Kimble squirrel-cage motors, is elimination of crevices that catch dust and dirt. Information on sizes and types of these motors is contained in Bulletin B-201, available on request from Star-Kimble Division of Miehle Printing Press and Manufacturing Company, 201 Bloomfield Avenue, Bloomfield, New Jersey.



YOU GET THESE 5 ADVANTAGES

when you use Star-Kimble Squirrel-Cage Motors

- *Sturdy construction.* Frames through NEMA 364 are of rigid cast construction, with more internal ribs than are used in conventional design, giving added strength and better heat dissipation. Larger frames are made of steel.
- *Simplified maintenance.* Double-width cartridge bearings are prelubricated—need no attention for many years.
- *Versatility of mounting.* Standard NEMA horizontal, D Flange, C Face, P Ring. Motors through frame 320 can be made dripproof in any mounting position—simply by rotating end shields.
- *Extra insulation.* Safety factor is provided for possible rises above rated temperature—motor life is lengthened, maintenance reduced.
- *Simplified design.* Lines are smooth, with no dust- and dirt-catching crevices. Fewer basic parts—greater interchangeability. Basic parts stocked for immediate shipment.

Star-Kimble Squirrel-Cage Motors are available in NEMA frames 203-505, and in NEMA Designs "B", "C" and "D." Also in larger sizes. Write for Bulletin B-201.

***Demanded by industry for tough start-and-stop jobs**

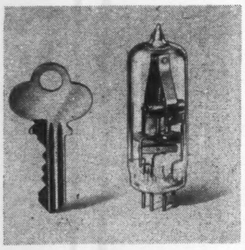
STAR-KIMBLE
MOTOR DIVISION OF
MIEHLE PRINTING PRESS AND MFG. CO.
201 Bloomfield Avenue Bloomfield, New Jersey

MINIATURE THERMAL RELAY 13

. . . hermetically sealed in glass

Thomas A. Edison Inc., West Orange, N. J.

Particularly adapted to airborne equipment, this relay is designed to economize on space and weight.



Designation: 207.

Size: ¾-in. diam, 2¼ in. seated height; weight, ½-oz.

Service: Time-delay relay operation, with delay periods from 5 to 120 sec; contacts rated 2.5 amp at 125 a-c, 1.0 amp at 125 v d-c; compensated for ambient temperatures from −60 to +85 C; heater voltages (standard), 6.3, 27.5 or 115 v a-c or d-c.

Design: Thermal type; hermetically sealed in T-5½ glass envelope; miniature button 7-pin base.

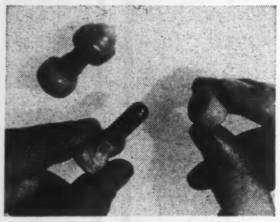
For more data circle MD 13, Page 191

NUTS AND BOLTS 14

. . . plastic-encased for corrosion resistance

Steere Enterprises, 70 *S. Canal St., Akron* 8, *O.*

Low-carbon steel nuts and bolts, encased in vinyl plastic, can replace more expensive stainless-steel fasteners.



Size: ⅜-16 cap screws and hex nuts standard, others available; approximately $\frac{3}{64}$-in. thick coating, depending on preheat, plastic formulation and immersion time.

Service: As fasteners, forming a permanently liquid-tight seal around bolt hole; coating is chemically inert at temperatures to 150 F; plastic formulation can be compounded to provide resistance to particular set of conditions; semihard coating satisfactory for installation with conventional socket wrenches.

Design: Low-carbon steel or brass nuts and bolts are coated by dipping in Geon vinyl plastic; satisfactory sealing surface formed by dipping to provide a sleeve, although flat sealing surface on under-side of bolt head can be accomplished by separate facing operation; coatings can be varied from soft to hard (maximum in excess of Shore Durometer hardness A100.)

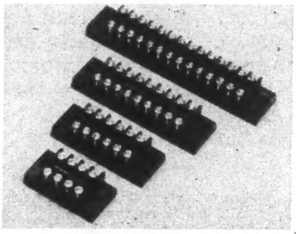
For more data circle MD 14, Page 191

TERMINAL BOARDS 15

. . . according to government specification

Auburn Button Works, Auburn, N. Y.

Having just completed a large order for the U. S. Bureau of Ships, this company is now in a position to supply both regular and feed-through styles.



Size: Feed-through type—6⅛, 7⅜, 8½ in. long with 8, 10 and 12 feed-through terminals respectively; regular type—2½, 3⅜, 4⅝, 6½ in. long with 8, 12, 18 and 28 terminals respectively.

Service: For electrical connection of each circuit to same binding post with regular type, to opposed and connected binding posts on feed-through type.

Design: According to U. S. Bureau of Ships specification 9000-6505-F-73214; molded of mineral-filled molding compound, specification MIL-P-14A.

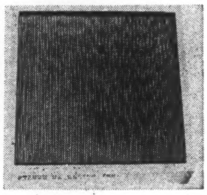
For more data circle MD 15, Page 191

AIR FILTERS 16

. . . are 99.95 per cent efficient

Cambridge Corp., 350 *S. Geddes St., Syracuse, N. Y.*

Although filtering efficiency is high, pressure drop across the filter is very low.



Designation: Absolute Filter.

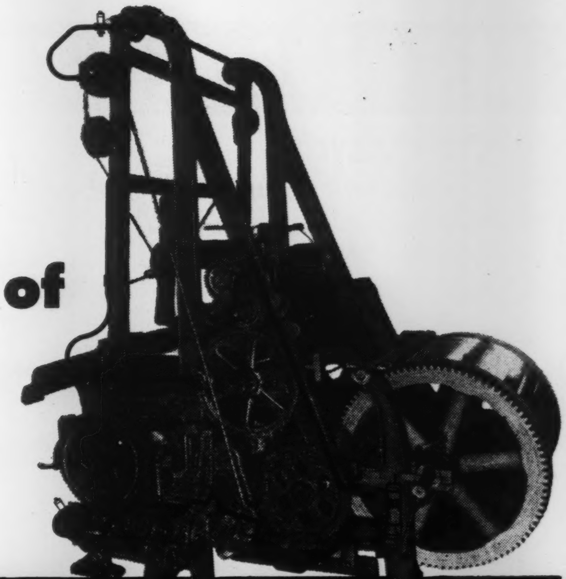
Size and Service: Removes dust, smoke and fume particles below 0.3-micron (12 x 10^{-6} in.) diam; removes more than 99.95% of all particles in air stream; pressure drop, 1 in. water at rated flow (clean filter); life, 1-3 years with proper prefiltering; capacity and size (without gaskets) as follows:

Model	Air Flow (cfm)	Dimensions (in.)		
		Height	Width	Depth
A-25	15	8	8	$6\frac{1}{16}$
A-50	40	8	8	5⅞
A-250	200	24	24	$3\frac{1}{16}$
A-600	500	24	24	5⅞
A-1000	850	24	24	11½

Design: Specially treated pulp and asbestos-fiber paper filtering element, pleated and sealed into frame; rubber gaskets on one or both sides available.

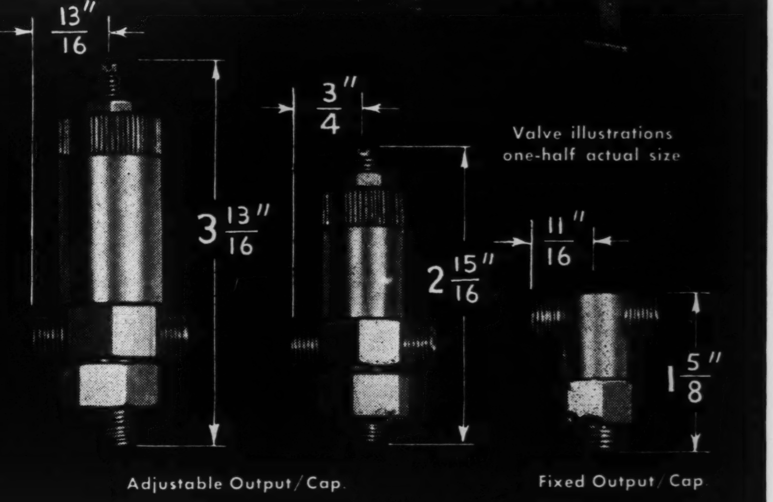
For more data circle MD 16, Page 191

It's simple to design this "insurance" of greater production into your machines



ALEMITE

Accumeter SYSTEM



Valve illustrations one-half actual size

Adjustable Output/Cap

Fixed Output/Cap

Virtually any machine that must be lubricated with fluid oils or light greases can have the protection of automatic *mechanized* lubrication. Alemite's Type I Accumeter System is the answer! So simple, so compact is this versatile *single line* system, that you can incorporate it in your designs with remarkable ease.

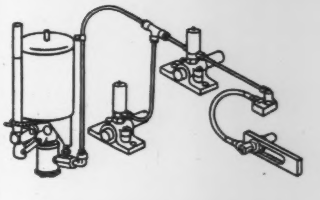
The Alemite Type I Accumeter Automatic Lubrication System consists of a lubricant pump, a distribution system of tubing, and *force-feed* valves mounted on or near individual bearings.

From one central point, it safely, surely lubricates all the bearings on a machine . . . automatically . . . while production goes on. Increases output by eliminating shutdown for lubrication! Ends the risk of lubrication errors or neglect by your customers! Reduces maintenance and repair costs, prolongs machine's life.

Alemite Accumeter Systems meter lubricants with a sustained accuracy unmatched by any other method. In fact, tests show *no variation* in the amount of lubricant discharged to bearings . . . even after 73,312 lubrication cycles—equivalent to 122 years of twice-a-day service!

What's more, Alemite Accumeter Automatic Lubrication is not merely "one-shot" lubrication. It is *continuous* between cycles. That's because Alemite's exclusive "accumulating" feature *prolongs* the discharge of lubricant to bearings.

Alemite Accumeter Automatic Lubrication is adaptable to machines of every type and size. There are three separate systems, to cover your full range of needs. Write now for Form 22-189, a free 16 page brochure giving full data. And for specific application recommendations, include description of machines you are presently working on. Alemite, Dept. R-22, 1850 Diversey Parkway, Chicago 14, Illinois.



This *Single Line* System Serves Any Type Bearings

Alemite's Type I Accumeter System can meter oil or grease to rotary, oscillating, stationary — plain or anti-friction bearings. Serves up to 400 bearings. Valves for any bearing capacity. FIXED or ADJUSTABLE output.

ALEMITE

REG. U. S. PAT. OFF.

ACCUMETER AUTOMATIC LUBRICATION
1850 Diversey Parkway, Chicago 14, Illinois

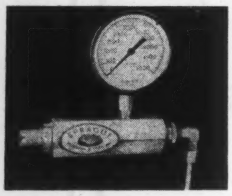
A PRODUCT OF
SW
STEWART WARNER

NEW PARTS AND MATERIALS

SHUTOFF VALVE 17

. . . protects pneumatic or hydraulic gages

Sprague Engineering & Sales Corp., 1144 W. 35th St., Gardena, Calif.



Gages are automatically cut out from the system when pressure goes beyond operating limits.

Designation: S-214, S-214A.

Size: 5½±½-in. long, 1½ in. hex; pressure inlet, ½-in. pipe thread; gage connection, ¼-in. pipe thead.

Service: Automatically cuts out gage from system, and opens pipe gage to system when pressure goes above or below maximum gage limit, respectively; 214 for 30, 60, 100, 200 and 300 psi; 214A for 500, 1000, 1500, 2000, 2500, 3000 and 5000 psi; coarse adjustment by replacing compression spring; fine adjustment by adjusting screw.

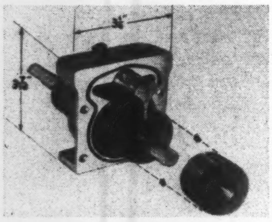
Design: Piston is held open by compression spring; when pressure rises above safe value, piston is forced to shutoff position; O-ring seals; AN adapters for aircraft fittings available.

For more data circle MD 17, Page 191

STAINLESS-STEEL PUMPS 18

. . . feature inert plastic impellers

Eco Engineering Co., 12 New York Ave., Newark 1, N.J.



Having high acid, alkali and chemical resistance, these pumps are useful for pumping small volumes of liquids.

Designation: Allchem.

Size: Ports tapped for ⅜, ½ or ¾-in. pipe; mounting plate, 3¼ x $3\frac{7}{16}$ in.

Service: Pumping acids, alkalis, emulsions, or organic solvents; capacity, 1 to 20 gpm; pressure to 40 psi; self-priming; Teflon impellers not subject to thermal shock or galvanic attack by pitting or erosion; will not swell, shrink, harden or crack; do not absorb moisture; will not contaminate fluid being pumped.

Design: Positive displacement type; Teflon impellers and stuffing-box packing; Teflon or Graphitar self-lubricating bearings; stainless-steel shafts; pump housing in No. 316 stainless steel casting or naval-bronze forging, full machined; pulley-drive base assembly or base-mounted for direct-connecting with electric motors.

For more data circle MD 18, Page 191

SILICONE-ALUMINUM PAINT 19

. . . resists high temperatures, corrosion

Tropical Paint & Oil Co., Cleveland 2, O.

Although rated for temperatures up to 1000 F, this paint has been used at temperatures to 1500 F with discoloration occurring, but no film failure.

Designation: Thermalite.

Form: Available in partitioned 1-gal containers containing fluid and dry aluminum pigment, mixed before application.

Service: Protective coating in temperature range 200 to 1000 F; resists rust, chemical fumes and weather; will not burn, flake or discolor; requires 200 F temperature for 1 hr after application to "set" the paint; no thinners added.

Properties: Silicone and metallic aluminum solids; silicones help to adhere metallic solids to metal surfaces.

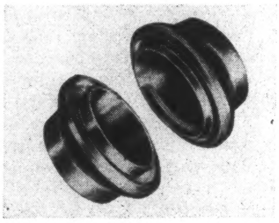
Applications: Airplane and diesel-engine exhaust stacks; engine mufflers, manifolds, blocks; engine choke housings; boiler fronts; vulcanizers, baking ovens; steam lines.

For more data circle MD 19, Page 191

WELDING COUPLING 20

. . . eliminates scale from piping systems

Tube Turns Inc., 224 E. Broadway, Louisville 1, Ky.



A circumferential cavity beneath the beveled welding area prevents burn-through, formation of "icicles," and scaling.

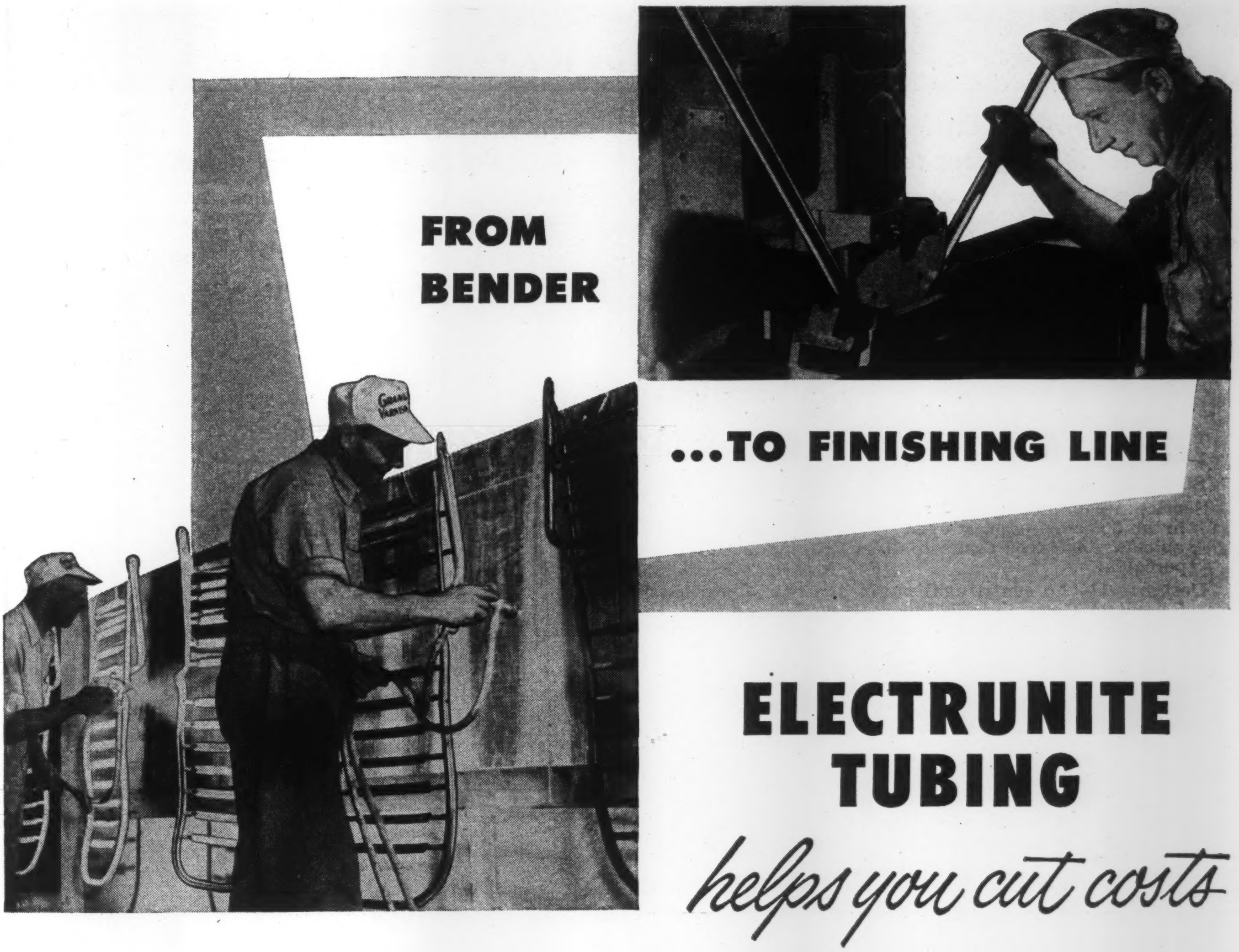
Designation: SF.

Size: 1¼ through 12 in. pipe size.

Service: Connecting piping carrying hydraulic fluids, high-pressure steam, compressed air, chemicals and gases, lubricating oil, food products; piping is easy to align; scale or protrusion formation on attachment welds is easy to remove, since coupling hubs are short; scale does not form on inside of tubing on coupling welds; leakproof if properly welded; strength is same as pipe itself; coupling joint is smooth.

Design: Tongue on one half of coupling slips into groove in other half; beveled welding area, with circumferential groove beneath area; available in carbon or stainless steel, aluminum and other metals and alloys.

For more data circle MD 20, Page 191



ELECTRUNITE TUBING

helps you cut costs

● Once your fabricating line is set, you can run ELECTRUNITE Tubing hour-after-hour, getting identical bends and shapes. ELECTRUNITE Tubing is uniform in dimensions, uniform in structure, uniform in ductility.

On your finishing line, you apply the finish to the clean, homogeneous surface of ELECTRUNITE Tubing. Whether it's painted or plated, there's no problem of adjusting finishing procedures from piece to piece to get uniform product finishes.

Let us tell you about Republic ELECTRUNITE Tubing . . . and about our Republic 3-Dimension Metallurgical Service that combines the knowledge and experience of field, mill, and laboratory metallurgists to help you.

REPUBLIC STEEL CORPORATION
STEEL AND TUBES DIVISION
224 EAST 131st STREET • CLEVELAND 8, OHIO

FREE BOOKLET

Write for Booklet SPD-52 . . . contains data and case histories on ELECTRUNITE Tubing applications.

REPUBLIC STEEL

ELECTRUNITE TUBING

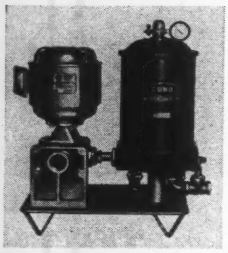
Made by the fabricators of ELECTRUNITE Boiler Tubes . . . the *original* electric-resistance-welded pressure tubes

NEW PARTS AND MATERIALS

PUMP AND FILTER UNIT 21

. . . for filtering leak-test liquids

Ruthman Machinery Co., Cincinnati 2, O.



Specifically built for filtering liquids used in testing refrigerator compressors, this unit completely circulates the liquid through the filter twice each hour.

Designation: 48380.

Size: 24 in. long, 15 in. wide, 40 in. high.

Service: Pumping and filtering 2000 gal of liquid per hr at 36 psi pressure; open or closed systems; suitable for leak-test tanks to 1000 gal capacity; semiportable.

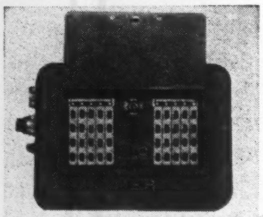
Design: 1½ hp centrifugal pump in vertical position; Schwitzer-Cummins friction seal; Cuno bronze filter (model 6-A1), supplied with 6 medium-density filters.

For more data circle MD 21, Page 191

AUTOMATIC CYCLE CONTROLLER 22

. . . "bumps" and "breathes" molding presses

Emmett Machine & Mfg. Co., 2249 Fourteenth St. SW, Akron 14, O.



Capable of accurate timing and close control of press opening distance, this unit is particularly suited to plastics and rubber presses.

Designation: Robotron E304.

Service: Controlling length of cure time and "bumping" action in molding presses; 0 to 19 bumps, variably timed, can be obtained; basic time interval for each cure-time pushbutton in right-hand panel is determined by motor rpm; selecting one of 20 pushbuttons determines length of cure time, with primary range being 20 to 40 times basic time interval; doubling or quadrupling of this time range is accomplished with a range switch, so that maximum cure time possible is 8 times minimum; number and timing of bumps is controlled by pushbuttons in left panel, with each of 20 pushbuttons representing a bump at the end of one basic time interval; start-stop pushbutton must be held down to hold press open when control is in automatic—can be used to close, bump and open press when hand-operated.

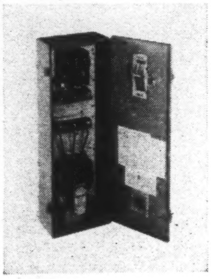
Design: Electronic control actuates solenoid valve which controls hydraulic system to open and close press; built-in pressure switch controls diaphragm valve to determine amount of bump opening.

For more data circle MD 22, Page 191

COMBINATION STARTER 23

. . . with fused disconnect switch

Westinghouse Electric Corp., Box 2099, *Pittsburgh* 30, *Pa.*



JIC Specifications are met by this combination across-the-line starter.

Designation: Class 11-204-N.

Size: NEMA sizes O through Z.

Service: For 3-phase a-c current to 600 v, 60 cycles; handle is slamproof; cover can be locked in off position by up to 3 separate padlocks.

Design: Disconnect switch with arc quenchers and visible blades, main-line fuse clips, and Life-Line-starter are mounted in common enclosure; handle has separate on, off and open cover positions; NEMA type I (general-purpose), IA (semidusttight), V (dusttight), or XII enclosures.

For more data circle MD 23, Page 191

ALUMINUM TUBING 24

. . . has good working and fatigue properties

Aluminum Co. of America, 683 *Gulf Bldg., Pittsburgh* 19, *Pa.*

Suitable for general-purpose applications, this tubing costs substantially less per foot than copper and other high-strength aluminum alloys.

Designation: Utilitube.

Size and Service: Handles petroleum products, fuel, gas, air, vacuum, and refrigerants with exception of methyl chloride; good flaring and forming characteristics; bends more easily and work hardens less than annealed copper; good vibration and corrosion resistance; has improved properties at temperatures down to −320 F; available in coiled lengths up to 1000 ft or more, depending on size; sizes and computed bursting pressures (based on minimum properties at operating temperatures less than 100 F) as follows:

OD (in.)	Wall Thickness (in.)	Bursting Pressure* (psi)	Weight† (lb per ft)
⅛	0.025	7380	0.0091
3/16	0.028	5260	0.0163
¼	0.032	4420	0.0255
5/16	0.035	3810	0.0355
⅜	0.049	4520	0.0584
⅜	0.035	3130	0.0435
½	0.049	3300	0.0808
½	0.035	2300	0.0595
⅝	0.049	2590	0.1032
¾	0.058	2550	0.1468

---

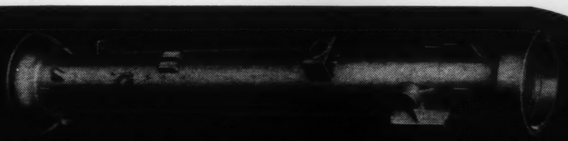
*No allowance made for effect of fittings or connections. Factor of safety of 4 is often used. †Based on 0.097 lb per cu in.

Design: Manufactured of new Alcoa alloy, B50S-0.

For more data circle MD 24, Page 191

COSTS CUT

VED



Garbage Disposer Housing

Carbon Pile Regulator

Air Connector

OVER 25 YEARS OF EXPERIENCE gained in the exacting manufacture of precision automotive and aircraft parts is back of Thompson's die and permanent mold castings.

New opportunities for cutting costs of intricate parts are offered to ALL INDUSTRY by Thompson Products' advanced developments in casting light metals in permanent mold and high-pressure dies.

Stronger, more durable parts that require less machining and finishing have dependable uniformity that eliminate costly scrap loss. And where finishing is required, Thompson's shop does the job better.

Whether it's an engine piston, a motor end frame, garbage disposer housing, carbon pile regulator, torque converter, launching barrel for a Bazooka, air connector or any one of many other parts, Thompson's creative engineers will gladly show you where and how you can simplify your operations with light metal castings and save on costs.

Write or call Light Metals Division, Thompson Products, Inc., 2269 Ashland Road, Cleveland 3, Ohio and a competent representative will call to help you plan new parts or re-design old ones.

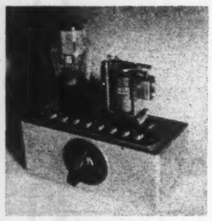
2269 ASHLAND ROAD • • • CLEVELAND 3, OHIO

NEW PARTS AND MATERIALS

ELECTRONIC TIMER 25

. . . for adjustable, short cycles

Timetrol Co., P. O. Box 193, Rockford, Ill.



High accuracy is unaffected by supply voltage fluctuations.

Designation: 701.

Size: 6 in. long, 3 in. wide, 6 in. high.

Service: Continuously adjustable timing intervals from 0.05 to 20 sec; accuracy, within 0.5% of time cycle; relay rated 5 amp at 115 v noninductive; unit operates on 105-130 v, 50-60 cycles; supply voltage fluctuations do not affect relay operation; fast recycling.

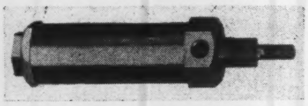
Design: Single-pole double-throw relay is actuated at end of time cycle; cycle is initiated by contact closure; panel or surface mounted; special models available.

For more data circle MD 25, Page 191

AIR CYLINDERS 26

. . . with interchangeable mounting adapters

H. G. Weber & Co. Inc., Kiel, Wis.



Foot and clevis-mounted adapters are added to a basic unit to make these cylinders almost universal in application.

Designation: Web-Aire.

Size: Stroke, 1, 2, 3, 4 or 6 in.; lengths—basic unit, 2 in. plus stroke—rod-end mounted, 2¼ in. plus stroke—clevis-mounted, 2¾ in. plus stroke; bore, 1⅛ in. diam; pipe tap, ¼-in.

Service: Output force (lb) equal to line input pressure in psi; maximum pressure, 200 psi.

Design: Steel head with interchangeable bronze bushings; theaded piston end accommodates adapters.

For more data circle MD 26, Page 191

FINE-DRAWN TUBING 27

. . . of welded low-carbon steel

Precision Tube Co. Inc., 3824 *Terrace St., Philadelphia* 28, *Pa.*

Finished size of this drawn welded tubing is much smaller than starting size, so that the weld line becomes invisible to the naked eye, and closely resembles the surrounding material.

Size: 0.010 to 0.500-in. OD; wall thickness down to 0.0015-in.

Service: As substitute for aluminum, copper, copper-base alloy, and other nonferrous and alloy metal tubing; finished product has characteristics very similar to seamless tube; can be easily bent, swaged, flared or machined.

Design: Welded low-carbon steel tube is redrawn to ⅕ original size; when proper amount of cold work, with correct annealing cycles, is employed, the weld area becomes totally recrystallized, and grain structure closely resembles surrounding material.

For more data circle MD 27, Page 191

SYNTHETIC O-RINGS 28

. . . for high-pressure applications

Parker Appliance Co., 17325 *Euclid Ave., Cleveland* 12, *O.*

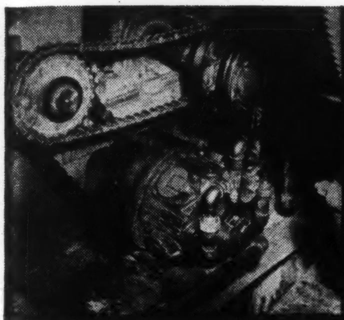
Having high heat resistance, low compression set and high hardness, these O-rings are designed for high-pressure applications in which oil resistance is required.

Designation: Compound 90.

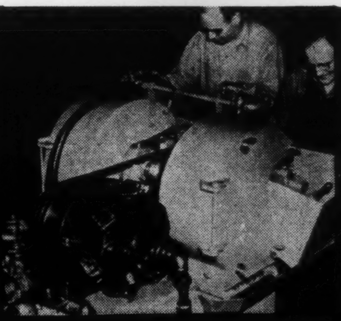
Size: Dynamic-seal series—88 standard sizes from 1/16 to ¼-in. ring diam, ¼ to 16 in. OD; static-seal series —⅛-in. ring diam, 1⅞ to 10¼ in. OD; specials to 4 ft OD.

Service: Sealing at temperatures up to 225 F; tensile strength, 1450 psi with no loss of strength after 7 days aging in air or AXS 808 oil at 158 F; elongation, 210, with 150 value after aging; hardness, Shore 90, unaffected by aging; volume swell in 7-day hot-oil test, 4.6%; exceed requirements of Army Ordnance Specification AXS 1440, Class A.

For more data circle MD 28, Page 191

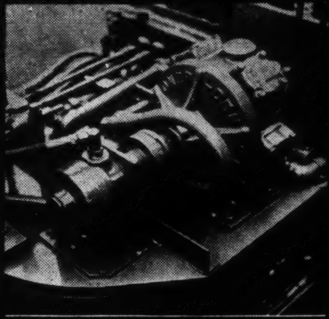


DRIVING FEED
ROLLS ON
SAWMILL [illegible]



WITH V-BELT
DRIVE TO
[illegible]

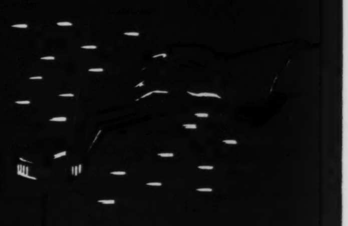
POWERING
HYDRAULIC PUMP
ON FORK
LIFT TRUCK



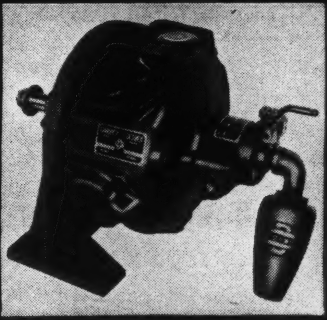
REGULATING [illegible]
VALVE [illegible]
GAS [illegible]

for winning moves . . .
design drives with
GARDNER-DENVER AIR MOTORS

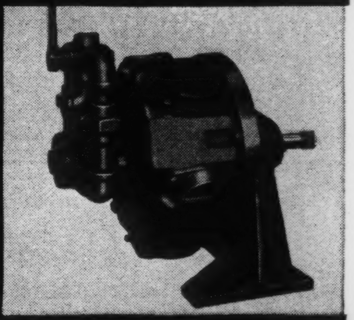
Powerful 5-cylinder, radial air motors—develop high starting torque—vibrationless at all speeds—instant reaction, simple controls—low weight per h.p.—eliminate fire hazards—cannot be damaged by overloads—infinite speeds from zero to maximum r.p.m.—sizes from 3 to 15 h.p.

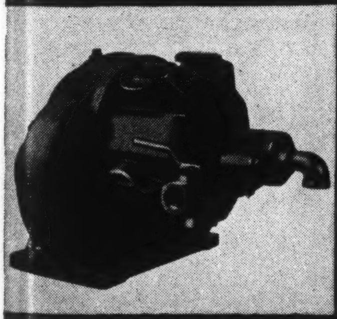


DIRECT DRIVE—
CAN BE INSTALLED
TO ROTATE IN
EITHER DIRECTION



DIRECT DRIVE—
WITH REVERSING VALVE

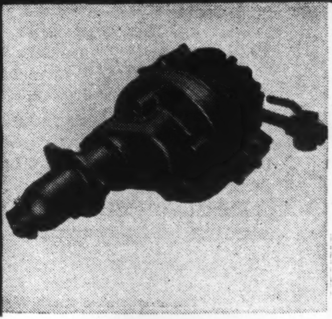




BUILT-IN GEAR
REDUCTION—CAN BE
INSTALLED TO ROTATE
IN EITHER DIRECTION

BUILT-IN
GEAR REDUCTION—
WITH REVERSING VALVE

AS AIR STARTER
FOR GAS
OR DIESEL
ENGINES



Write for performance curves and additional information.

GARDNER-DENVER

SINCE 1859

Gardner-Denver Company, Quincy, Illinois

THE QUALITY LEADER IN COMPRESSORS, PUMPS AND ROCK DRILLS

ENGINEERING DEPARTMENT

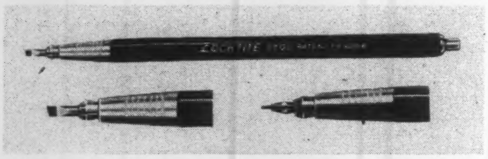
EQUIPMENT

For additional information on this new equipment, see Page 191

THIN DRAWING LEADS 29

. . . never need sharpening

A. W. Faber-Castell Pencil Co., Newark, N. J.



Held in a special holder, these flat leads can find wide use where straight-line drawing is a major part of the day's work.

Designation: Holder, No. 9600 Locktite; leads, No. 9040.

Size: Leads, 0.017 to 0.018-in. thick, 0.096-0.098-in. wide, 4 in. long.

Service: Drawing of continuous straight lines of positive uniformity; no sanding or sharpening required; available in degrees HB, F, H and 2H through 9H.

Design: Imported graphite drawing lead is held by patented internal chucking sections of holder.

For more data circle MD 29, Page 191

PENCIL CLOTH 30

. . . erased with liquid eradicator

Frederick Post Co., 3650 N. Avondale Ave., Chicago 18, Ill.

Major changes can be made quickly, without damaging the surface of the basic material. A free demonstration kit (shown) will be sent.

You Can Accomplish
THIS
TODAY

Designation: Whitex Smooth; Liquidator.

Size: 20-yd rolls, 30, 36 and 42 in. wide; sheets cut to size from standard widths on special order; liquid eradicator in 2-oz, pint, and quart containers.

Service: For pencil drawings, with erasure of large areas possible with liquid eradicator; wad of cotton, saturated with liquid, is wiped over pencil area; excess eradicator and graphite is removed with dry cotton; ink can be used.

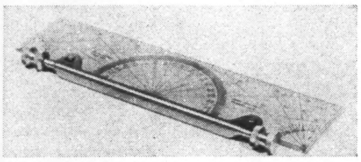
Design: Translucent cloth; demonstration kit, with cloth and liquid eradicator samples, two pencils and eraser, is available without cost.

For more data circle MD 30, Page 191

DRAFTING DEVICE 31

. . . increases speed on angular line layouts

Loomis Industries, Box 445, Berkeley 1, Calif.



Redesigned to eliminate slippage common in previous models, this drafting instrument is claimed to be particularly good for angular line layout and cross-hatching.

Designation: Paraline.

Size: 10¼ in. long, $3\frac{3}{16}$ in. wide.

Service: For ruling parallel lines, in place of T-squares, straightedges and triangles; requires no attachments or board clamps.

Design: Wide transparent scale, scribed with $\frac{1}{32}$-in. rule, protractor and triangle markings, is kept parallel to initial setting by two double rollers mounted on common shaft; metal parts incorporated in single section, eliminating slippage.

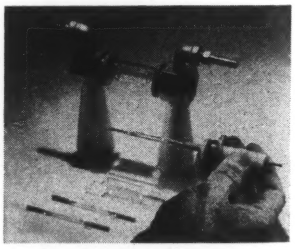
For more data circle MD 31, Page 191

HIGH-INTENSITY LIGHTS 32

. . . supply visible or ultraviolet light

Huggins Laboratories, 766 Hamilton Ave., Menlo Park, Calif.

Redesigned for smaller size and lower cost, these mercury-arc lamps supply unusual brilliance.



Size: Water jacket, approximately 1½ in. wide, 6 in. long; lamp, approximately 2 mm wide, 3 in. long; arc widths, 1, 1¼ and 1½ mm.

Service: Supplying high-intensity light of 40,000 to 90,000 candles per sq cm brilliance; light output, 65,000 to 130,000 lumens; operates from a-c, d-c, single-flash or stroboscopic power supply.

Design: Mercury arc lamp and water jacket made of glass for visible light or quartz for ultraviolet light; tap-water cooled; power input, 1 to 2 kw from reactive power source.

Application: High-speed and stroboscopic photography; optical apparatus.

For more data circle MD 32, Page 191

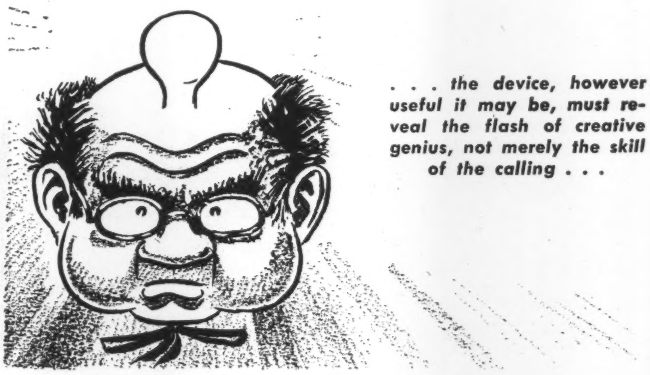
Combination Patents

(*Continued from Page* 126)

issues, but the number of patents the Supreme Court holds valid is smaller still.

"Flash of Genius" Test: Judge Learned Hand once said, "An invention is a new display of ingenuity beyond the compass of the routineer, and in the end that is all that can be said about it."[4] However, much more has been said about it, for better or worse. In 1941, in Cuno Engineering Corp. v. Automatic Devices Corp., the Supreme Court held invalid certain claims in a patent for an automobile cigarette lighter with automatic thermostatic control. The court said, "The device, however useful it may be, must reveal the flash of creative genius, not merely the skill of the calling."[5] It was widely supposed that this decision raised the standard of invention, and in subsequent cases the lower federal courts in many instances imposed a stricter standard of patentability than formerly—to the detriment of the unfortunate patentee who happened to be involved in litigation at that time.

It is impossible to impose a test of creative genius with any exactitude, and naturally the courts differed considerably in the type of patent which passed the test. Then in 1949 the Court of Appeals of the 7th Circuit held valid and infringed certain claims of a patent relating to drapery mountings. The court said, "We hold that the trial court herein erred in construing the phrase, 'flash of genius,' as adding a test for invention of a higher degree or superior to that which would have produced patentable invention under the law as it existed prior to the Cuno decision. . . . We reject the flash of genius test. We shall concentrate our scrutiny on whether, in the claimed invention, Falkenberg displayed more ingenuity than a workman skilled in his line of work."[6] The Supreme Court denied appeal during the 1950 term of court[7]—so we have come a full circle and are back to our starting point, it would seem, so far as the "flash of genius" test is concerned.



. . . the device, however useful it may be, must reveal the flash of creative genius, not merely the skill of the calling . . .

Combination Patents: The same fate is probably awaiting a decision of the Supreme Court rendered in December, 1950, relating to a combination patent. Although "combination" and "aggregation" may carry about the same connotation to the layman, in patent parlance there is a distinction. To put the conclusion before the premise on which it is based, a combination is patentable whereas an aggregation is not. The lead pencil with an eraser on one end, which we use so commonly today, is an example of an aggregation. The lead is used to write and the eraser to erase, but there is no interaction between the parts. In 1875 the Supreme Court invalidated a patent for this aggregation saying, "The combination, to be patentable, must produce a different force or effect, or result in the combined forces or processes, from that given by their separate parts. There must be a new result produced by their union; if not, it is only an aggregation of their separate elements."[8]

. . . the Constitution never sanctioned the patenting of gadgets . . .

In the combination patent case before the Supreme Court in 1950, Great Atlantic and Pacific Tea Co. v. Supermarket Equipment Corp., Justice Jackson described the patent in this way, "Stated without artifice, the claims assert invention of a cashier's counter equipped with a three-sided frame, or rack, with no top or bottom, which, when pushed or pulled, will move groceries deposited within it by a customer to the checking clerk and leave them there when it is pushed back to repeat the operation. It is kept on the counter by guides. That the resultant device works as claimed, speeds the customer on his way, reduces checking costs for the merchant, has been widely adopted and successfully used, appear beyond dispute."[9] The claims involved were held to be invalid. "Only when the whole in some way exceeds the sum of its parts is the accumulation of old devices patentable."[10]

Justice Jackson said further, "Courts should scrutinize combination patent claims with a care proportioned to the difficulty and improbability of finding invention in an assembly of old elements. The function of a patent is to add to the sum of useful knowledge. Patents cannot be sustained when, on the contrary, their effect is to subtract from former resources freely available to skilled artisans. A patent for a combination which only unites old elements with no change in their respective functions, such as is presented here, obviously withdraws what already is known into the field of its monopoly and diminishes the resources available to skillful men."[11]

This is a perfectly defensible abstract theory of law relating to combination patents. Many people may disagree with it, but it is understandable that

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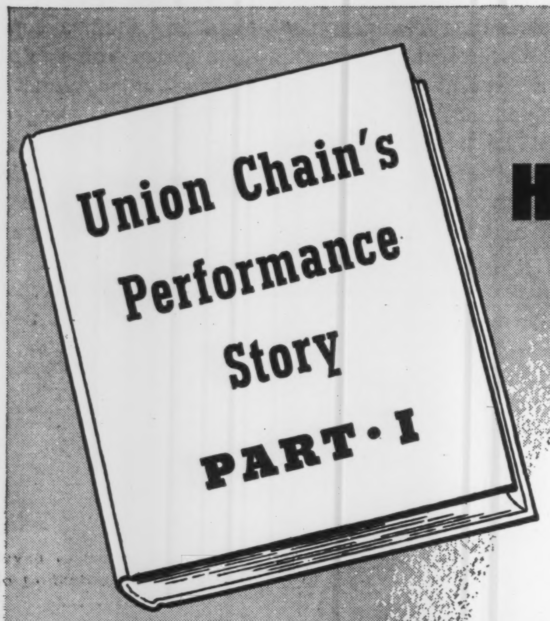

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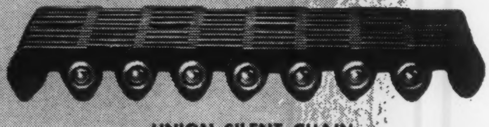
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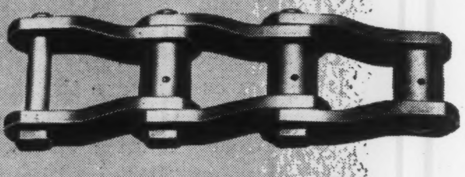
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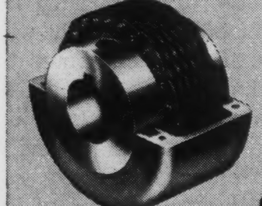
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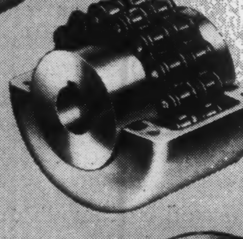
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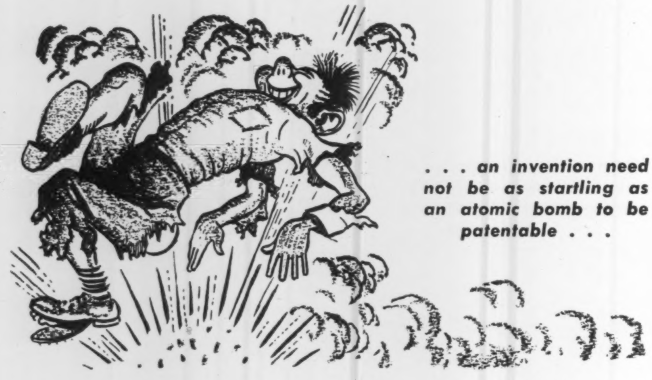
(*Continued from Page* 195)

the court would invalidate a combination patent which adds nothing new, for the effect of such a patent is to withdraw from common use whatever its subject may be unless tribute is paid to the patentee.

Constitutional Restraints: However, the concurring opinion of Justice Douglas (with whom Justice Black agreed) caused the real storm which broke over this case. Justice Douglas said, "It is worth emphasis that every patent case involving validity presents a question which requires reference to a standard written into the Constitution. Article I, Section 8, contains a grant to the Congress of the power to permit patents to be issued. But, unlike most of the specific powers which Congress is given, that grant is qualified. The Congress does not have free rein, for example, to decide that patents should be easily or freely given. The Congress acts under the restraint imposed by the statement of purpose in Art. I, Section 8. The purpose is 'To promote the Progress of Science and useful Arts. . . .'



. . . an invention need not be as startling as an atomic bomb to be patentable . . .

"The invention, to justify a patent, had to serve the ends of science—to push back the frontiers of chemistry, physics, and the like; to make a distinctive contribution to scientific knowledge. That is why through the years the opinions of the Court commonly have taken 'inventive genius' as the test. It is not enough that an article is new and useful. The Constitution never sanctioned the patenting of gadgets. Patents serve a higher end—the advancement of science. An invention need not be as startling as an atomic bomb to be patentable. But it has to be of such quality and distinction that masters of the scientific field in which it falls will recognize it as an advance."[12] This analysis completely ignores the second part of the purpose of patent protection, as given in the Constitution and as quoted by Justice Douglas, which is to promote the useful arts. And it can hardly be doubted that most patents relate to the useful arts rather than to the progress of science. That such was the intention of the framers of the Constitutional provision has been demonstrated to the satisfaction of specialists in the field of patent law.

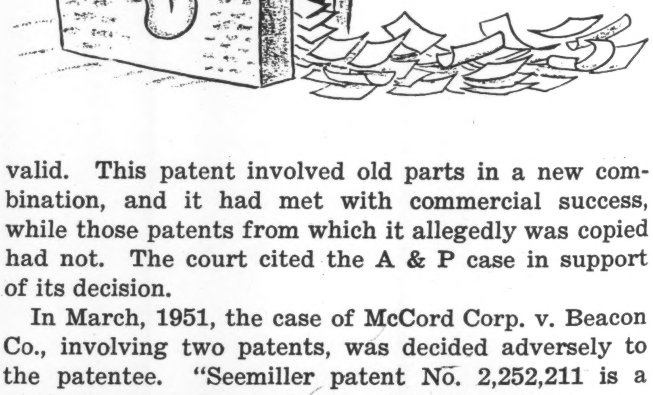
"Gadget" Patents: Justic Douglas went on to say, "The Patent Office, like most administrative agencies, has looked with favor on the opportunity which the exercise of discretion affords to expand its own jurisdiction. And so it has placed a host of gadgets under the armour of patents—gadgets that obviously have no place in the constitutional scheme of advancing scientific knowledge."[13] He here cites a number of patent cases decided between 1850 and 1893, although these patents could hardly have been granted by anyone currently working in the Patent Office.

The opinion concludes, "The patent involved in the present case belongs to this list of incredible patents which the Patent Office has spawned. The fact that a patent as flimsy and as spurious as this one has to be brought all the way to this court to be declared invalid dramatically illustrates how far our patent system frequently departs from the constitutional standards which are supposed to govern."[14]

From the furor caused by Justic Douglas' opinion, one might have thought that it stated the opinion of the Court. It did not, of course, but concurring opinions—and dissenting opinions too—have in times past set forth theories subsequently adopted by the Court. While such is possible in this case, it would appear to be extremely doubtful. Justice Douglas' opinion is not defensible historically or practicably.

Federal Court Interpretations: The majority opinion in the A & P case does state the law which the Supreme Court expects the lower federal courts to follow, but how they follow it must depend on the individual judges.

In Apel v. Connolly, decided January 22, 1951, the patent in suit was, according to the headnote, "for a device which trapped air under speedboat and made air move under speedboat and released air without creating vacuum or draw, and for construction of stabilizers or pontoons outside of hull of speedboat to provide a planing surface, and at the same time to aid in trapping of air,"[15] and this patent was held valid. This patent involved old parts in a new combination, and it had met with commercial success, while those patents from which it allegedly was copied had not. The court cited the A & P case in support of its decision.



. . . the patent involved in the present case belongs to this list of incredible patents which the Patent Office has spawned . . .

In March, 1951, the case of McCord Corp. v. Beacon Co., involving two patents, was decided adversely to the patentee. "Seemiller patent No. 2,252,211 is a product patent for an improved heat exchange core of the type used in the radiators of internal combustion engines, such as those of motor vehicles or airplanes, and patent No. 2,252,210 is for an improved

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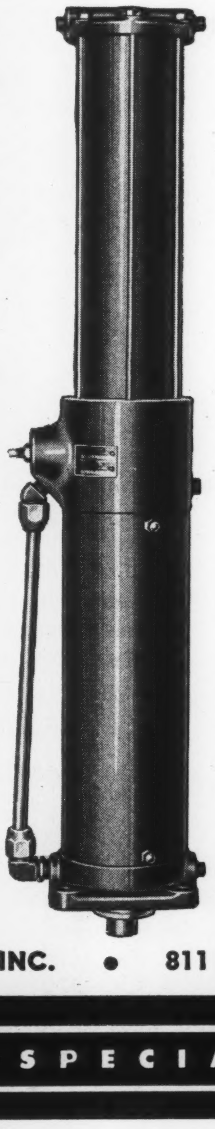

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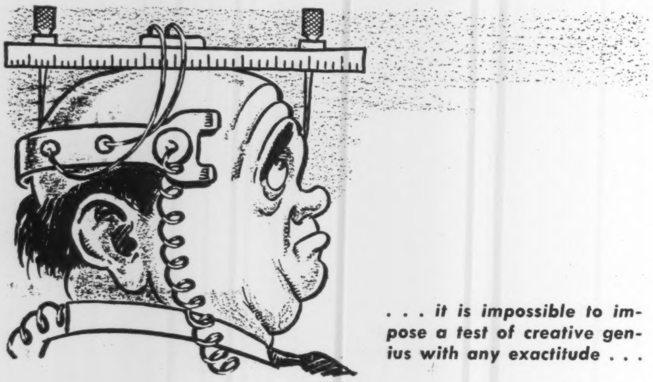
method of manufacturing such a core."[16] The A & P case was cited many times, in every instance to the detriment of the patents involved. "Commercial success cannot make a patent valid where invention is lacking,"[17] the court said, and Justice Jackson had said the same thing in slightly different words.

"To sum up, it is the opinion of this court that the product patent in suit . . . runs head-on into the principles of the Great Atlantic and Pacific Tea Co. case . . . and the Lincoln Engineering Co. v. Stewart-Warner Corp. . . . As stated, the combination of elements disclosed in the product patent is old. They did not perform nor produce any new or different function or operation in the product than they did before. It may be true the combination produced results a little more striking perhaps than any previous utilization, but they were, at best, differences in degree. . . .

Degree of Excellence: "I have followed the mandate of the Great Atlantic and Pacific Tea Co. case and have scrutinized the patent claims in suit 'with a care proportioned to the difficulty and improbability of finding invention in an assembly of old elements' . . . and find the product patent has subtracted from former resources freely available to skilled artisans. Whatever results the patentee produced over the prior art were differences in degree and were due solely to better mechanical construction within the competence of a skilled mechanic. Nothing additional is found, no new use could be made of it, and obviously differences in degrees of excellence are not patentable invention."[18]



. . . it is impossible to impose a test of creative genius with any exactitude . . .

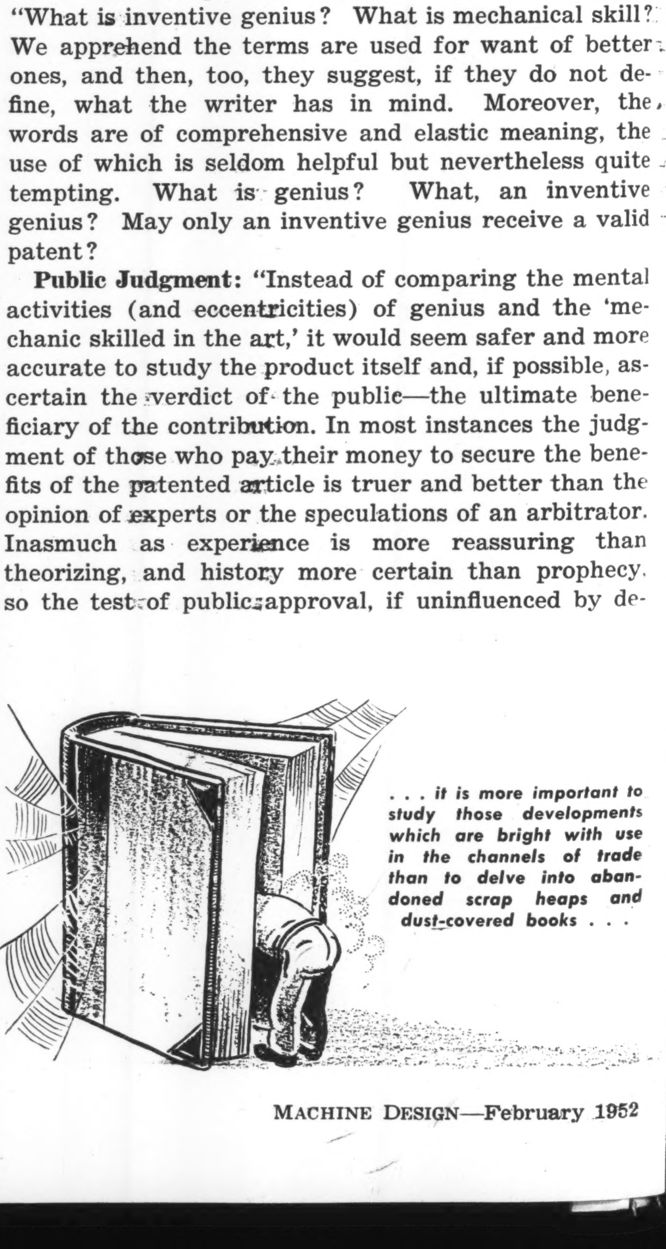
That differences in degrees of excellence are not ordinarily patentable is quite true, but that is not invariably the rule. The principal difference between Edison's patent No. 223,898 for an incandescent light and previous patents in the field was the reduction of the filament from 1/32-inch to 1/64-inch or less, and this patent was held valid. "In a sense it may be said that Edison only made them [carbon burners] more stable than they were before; that it is a mere matter of degree. But the degree of difference between carbons that lasted one hour and carbons that lasted hundreds of hours seems to have been precisely the difference between failure and success, and the combination which first achieved the result 'long desired, sometimes sought and never before attained,' is the patentable invention."[19]

Commercial Success: As a criterion of patentability commercial success can be overemphasized, of course. Justic Jackson, in the A & P case, said, "Commercial success without invention will not make patentability."[20] No one would argue with this statement, but the Court of Customs and Patent Appeals, in dealing with certain patent claims rejected by the Patent Office and the Board of Appeals, had this to say, "Evidence of commercial success in situations like that at bar, where the question of the presence of invention is in controversy and where there are differences of opinion such as prevail here between the Patent Office and this court, should be an important factor to consider."[21]

Some years ago a patent claim involving vibrators of a type used for massage and similar purposes was before the Court of Appeals for the 7th Circuit. Judge Alschuler said, "It is the theory of the appellant [patentee] that the novelty upon which his claim of invention is predicated lies in the particular type of its structure, not in the introduction of new elements, nor in the elimination of old elements of the combination. In other words, asserted inventibility is traceable to the particular form, weight, and size of the casing, coupled with the position of the vibrator actuator, and the shaping of the casing so as to use it as a handle."[22]

As a test of patentability, he had this to suggest, "What is inventive genius? What is mechanical skill? We apprehend the terms are used for want of better ones, and then, too, they suggest, if they do not define, what the writer has in mind. Moreover, the words are of comprehensive and elastic meaning, the use of which is seldom helpful but nevertheless quite tempting. What is genius? What, an inventive genius? May only an inventive genius receive a valid patent?

Public Judgment: "Instead of comparing the mental activities (and eccentricities) of genius and the 'mechanic skilled in the art,' it would seem safer and more accurate to study the product itself and, if possible, ascertain the verdict of the public—the ultimate beneficiary of the contribution. In most instances the judgment of those who pay their money to secure the benefits of the patented article is truer and better than the opinion of experts or the speculations of an arbitrator. Inasmuch as experience is more reassuring than theorizing, and history more certain than prophecy, so the test of public approval, if uninfluenced by de-



. . . it is more important to study those developments which are bright with use in the channels of trade than to delve into abandoned scrap heaps and dust-covered books . . .

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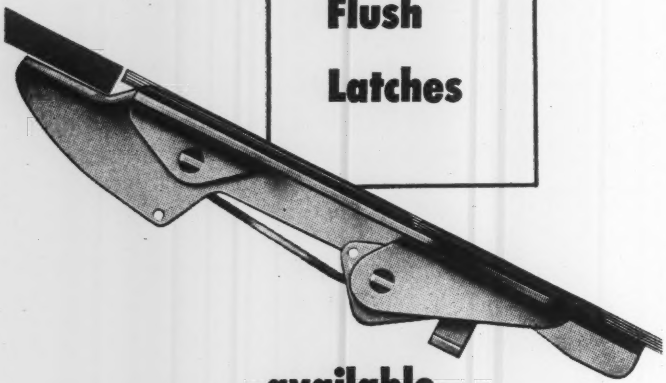

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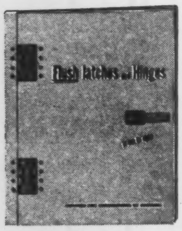

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tracting factors, must afford the weightiest proof obtainable determinative of invention.

"In short, in construing the patent statute, which was enacted to promote the useful arts, it is more important to study those developments of the art which are bright with use in the channels of trade than to delve into abandoned scrap heaps and dust-covered books which tell of hopes unrealized and flashes of genius quite forgotten. The somewhat meaningless terms 'inventive genius' and 'mechanical skill' must be clarified by an examination of the article itself, and if the improvement be unusual, or if there be doubt, and the public has given its tribute, the judge should accord the creator of the article the title of inventor."[23]

Same Test Is Used

Great commercial success attended the sale of the vibrator by the plaintiff; one competitor took a license to manufacture the vibrator; and the defendant copied plaintiff's vibrator without securing a license to do so. Of the defendant, the court asked, "The question exists, why change its type of vibrator unless the article copied possessed merit? And why was not the change made earlier if the article possessed merit and its production was obvious to a mechanic skilled in the arts?"[24] The claim involved was held valid and infringed. The test today is probably still the same as it has been for years—Is this an invention which could have been made by an ordinary workman skilled in the trade to which it appertains? If so, it is not patentable, but what a person skilled in the trade could develop is always questionable. "A problem solved is no longer a problem, and one is prone to overlook that it ever existed."[25]

Obvious Combinations: A specialized application of the "skilled in the trade" rule was applied by the Court of Customs and Patent Appeals in connection with an application for a patent in which the applicant "claimed invention in the construction of a heat exchanger such as a radiator used for water cooling purposes in an automobile or the like.

"Appellant's [applicant's] heat exchanger or radiator is formed of a plurality of multiple tube members, of which the tubular portion is a flattened cross section. The multiple tube members are positioned between heads in parallel edgewise relation crosswise of the radiator. It is stated that air flowing through such radiator is effectively agitated to cause good heat transfer between it and the walls of the tubing by venturi-like effect and also that the flattened cross section gives relatively extended surface."[26]

Regarding this the court said, "Of course, it is well-settled law that if one selects from the prior art well-known features in such a manner as to produce new, unobvious, unexpected and useful results which are not merely the accumulation of the good results taught by the art he has made an invention. Frequently combinations of old elements in new structures have resulted in inventions of a high order.

"However, it must be understood that the radiator art is a crowded one and that one who conceives of a new combination of old elements is rarely justified

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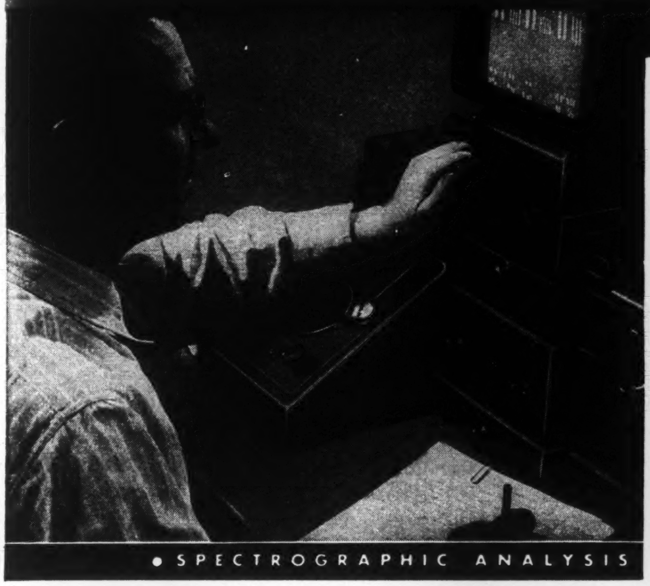

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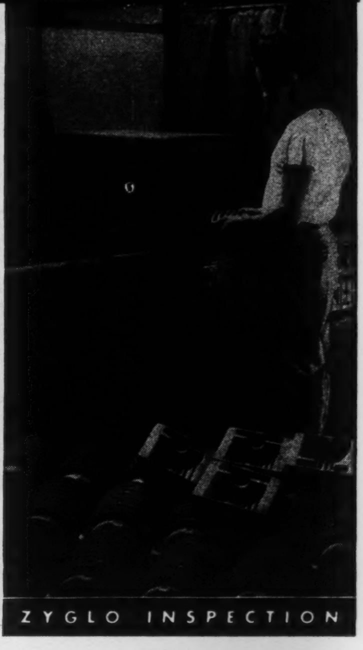

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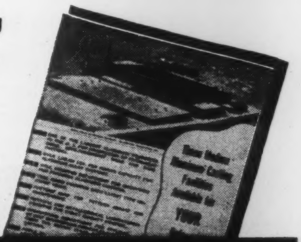

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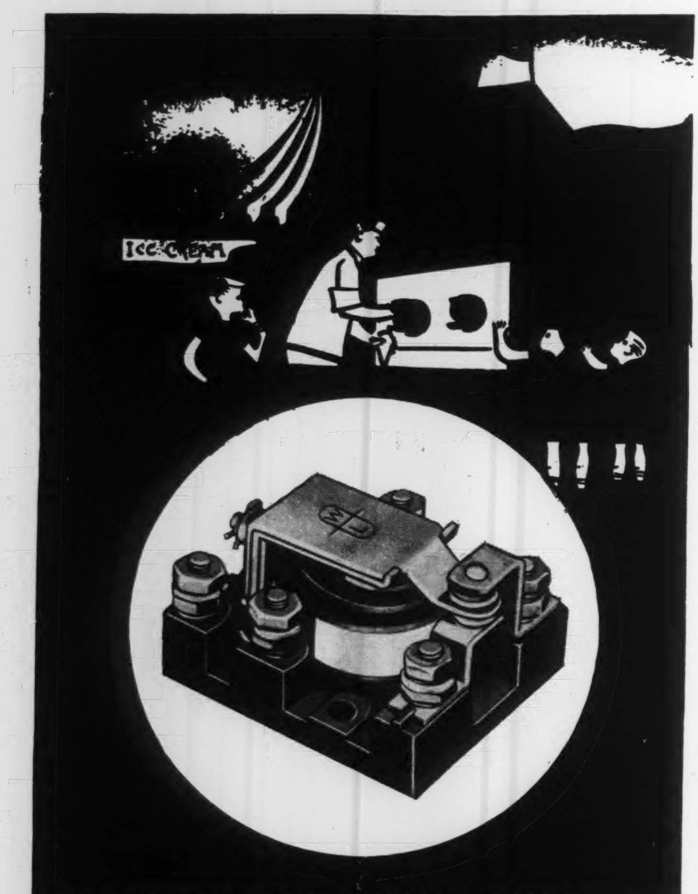

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in claiming patentability merely because he has produced some improvement and no one else has made the same combination."[27]

The court felt that the improvement here was not beyond the scope of a mechanic skilled in this particular trade, so the claims involved were justifiably refused by the Patent Office.

Anticipated Combinations: In combination patents a question of prime importance is whether the combination was anticipated by prior art or patents. "The prior art will not anticipate a patent for a combination unless it discloses 'all the elements of such combination, or their mechanical equivalents, functioning in substantially the same way to produce substantially the same result'; and a prior patent does not anticipate a subsequent patent where the prior patent failed to solve the problem which the subsequent patent solves successfully."[28]

Prior Patents Defeat Claims

The Doctrine of Equivalents is based on the theory that "if two devices do the same work in substantially the same way, and accomplish substantially the same result, they are the same, even though they differ in name, form, or shape."[29] The doctrine may be used to defeat the claims of a subsequent patent which accomplishes the same result as a prior patent in substantially the same way, even though the claims are not literally the same. It also may be used to restrict the claims of a prior patent where a later device accomplishes a similar purpose, coming within the literal words of the prior patent's claims although it uses a different principle or works in a substantially different way.

Utilizing Old Elements: A combination patent may utilize some element not previously used in this field but common in some other line, and of this use the Supreme Court has said, "Indeed, it often requires as acute a perception of the relation between cause and effect, and as much of the peculiar intuitive genius which is a characteristic of great inventors, to grasp the idea that a device used in one art may be made available in another, as would be necessary to create the device *de novo*. And this is not the less true if, after the thing has been done, it appears to the ordinary mind so simple as to excite wonder that it was not thought of before. The apparent simplicity of a new device often leads an inexperienced person to think that it would have occurred to any one familar with the subject; the decisive answer is that with dozens and perhaps hundreds of others laboring in the same field, it had never occurred to any one before. The practiced eye of an ordinary mechanic may be safely trusted to see what ought to be apparent to every one. . . .

"It may be said that, if the new use be so nearly analogous to the former one, that the applicability of the device to its new use would occur to a person of ordinary mechanical skill, it is only a case of double use, but if the relation between them be remote, and especially if the use of the old device produce a new result, it *may* at least involve an exercise of the inventive faculty. Much, however, must still depend upon the nature of the changes required to adapt the device to its new use."[30]

Extended Claims: The mistake which some patentees make is to claim more than their invention. Such was the case in Lincoln Engineering Co. v. Stewart-Warner Corp., where the court described the patent in this way, "The patent in suit has to do with apparatus for lubricating bearings, especially those of automobiles, by the use of the nipple or fitting connected with the bearing, a gun consisting of a compressor or pump for propelling the lubricant under high pressure, a hose or conduit to connect the pump with the fitting, and a means of coupling the conduit to the fitting to make a tight joint during the operation of greasing."[31]

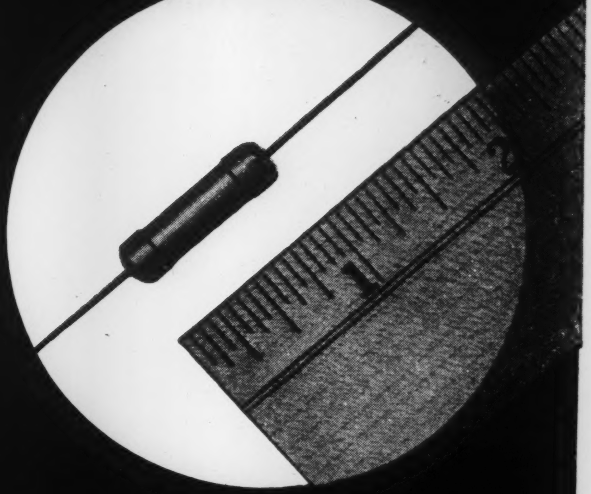
Regarding the patentability of this combination, the court said, "A headed nipple or fitting connected with the bearing, and to be coupled to the conduit from the grease gun, is old and unpatentable. A compressor or pump for propelling lubricant is old and unpatentable as such. The invention, if any, which Butler made was an improvement in what he styles in his specifications the 'chuck' and in his claim a 'coupling member.' It is not denied that multi-jawed chucks had been used in industry and as couplers in lubricating apparatus. Butler may have devised a patentable improvement in such a chuck in the respect that the multiple jaws in his device are closed over the nipple by the pressure of the grease, but we think he did no more than this.

Extended Claim Not Valid

"Having hit upon this improvement he did not patent it as such but attempted to claim it in combination with other old elements which performed no new function in his claimed combination. The patent is therefore void as claiming more than the applicant invented. The mere aggregation of a number of old parts or elements which, in the aggregation, perform or produce no new or different function or operation than that theretofore performed or produced by them, is not patentable invention. And the improvement of one part of an old combination gives no right to claim that improvement in combination with other old parts which perform no new function in the combination."[32]

Patent Requirements: The requirements for patentability of a combination have been well set forth in City of Grafton v. Otis Elevator Co., where Otis was suing the City and Warner Elevator Manufacturing Co. for infringement. "The requisites for a valid combination patent are thus set out, with an elaborate citation of authorities in 40 Am. Jur. 543, Section 19: 'A combination is a composition of elements some of which may be old and others new, or all old or all new. It is, however, the combination that is the invention and is as much a unit in contemplation of law as a single or noncomposite instrument.

" 'The authorities establish the following propositions respecting the patentability of devices or processes of this character: (1) that a combination is patentable if it produces new and useful results, although all its constituents were well known and in



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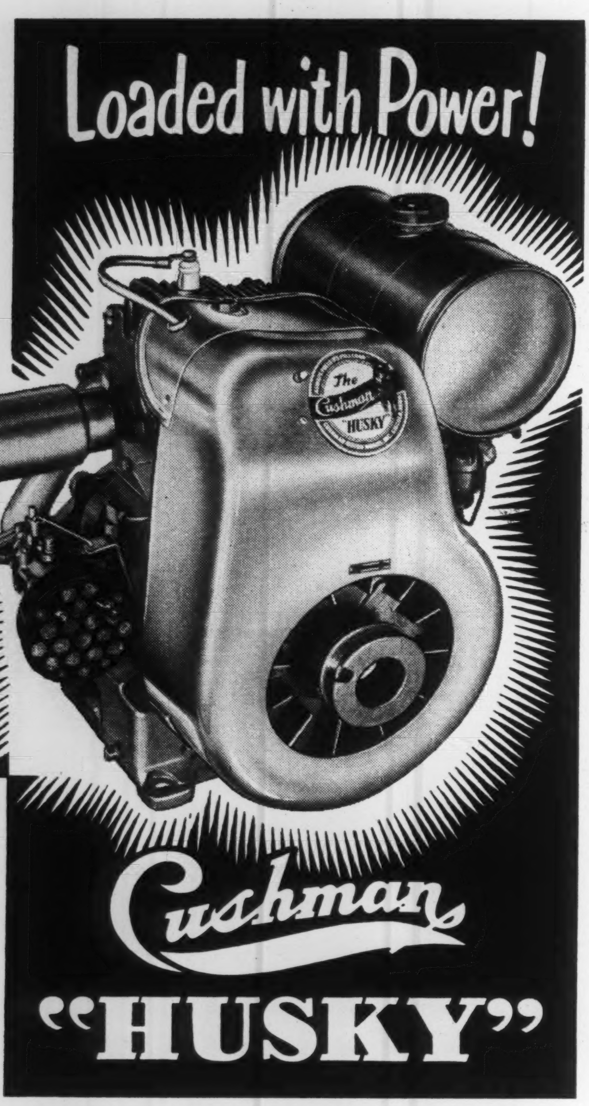

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common use before it was made, provided the results are a product of the combination and not a mere aggregate of several results, each the product of one of the combined elements; (2) if it produces a different force, effect, or result in the combined forces or processes from that given by their separate parts, and a new result is given by their union; (3) if it either forms a new machine of distinct character or formation, or produces a result which is not the mere aggregate of separate contributions, but is due to the joint and co-operating action of all the elements; (4) when the several elements of which it is composed produce by their joint action either a new and useful result, or an old result in a cheaper or otherwise more advantageous way.' "[33]

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"Despite the trend toward specialization each specialist engineer or other technical worker at the professional level must have a sound basic knowledge of underlying natural laws, principles, and techniques. The engineer must be thoroughly grounded in physics, and its engineering branches such as thermodynamics, mechanics, and hydraulics."—GRANVILLE M. READ, *chief engineer, E. I. du Pont de Nemours and Co.*

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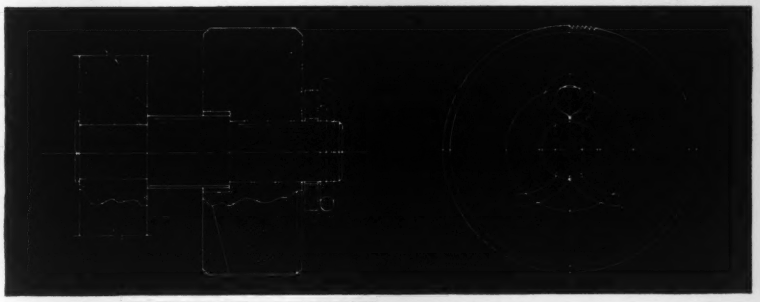

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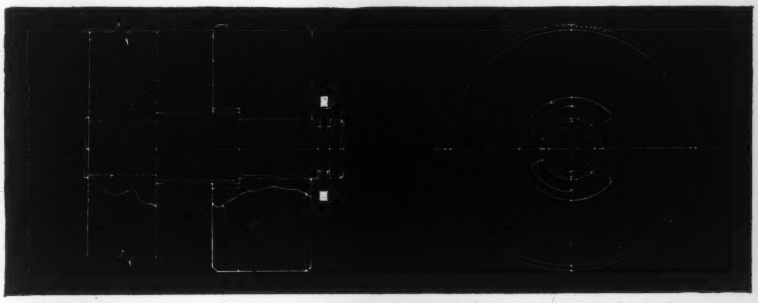

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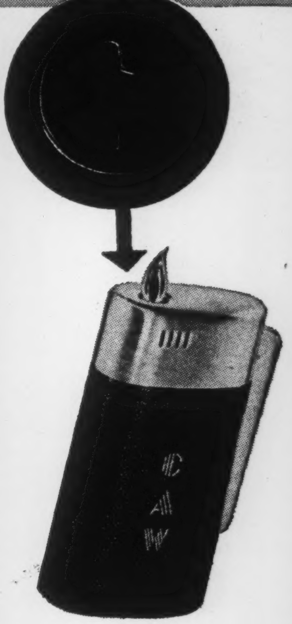

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Washer	1.50		
	2.44		9.03
Labor		***Labor***	
Shaft	10.22	Shaft	2.27
Washer	.72		
Assembly	9.28	Assembly	4.41
	20.22		6.68
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Adolph J. DeMatteo

The appointment of **Adolph J. DeMatteo** as chief engineer has been announced by the Watson-Stillman Co., Roselle, N. J. In his new position Mr. DeMatteo will direct the engineering activities of his company, designers and manufacturers of hydraulic machinery for the plastics, metalworking and railroad industries. A graduate of New York University with a B. M. E. degree, Mr. DeMatteo joined Watson-Stillman in 1944 and since 1946 has held the position of assistant chief engineer. He is a member of both the Society of Automotive Engineers and the American Society of Mechanical Engineers.

◆

Leonard Rockstrom

Cameron Machine Co., Brooklyn, N. Y., has appointed **Leonard Rockstrom** to the position of vice president in charge of engineering. He has served as chief engineer for the past two years. Mr. Rockstrom was formerly director of engineering for the F. X. Hooper Co., Glenarm, Md. During World War II he served with the Ordnance Design Section, Brooklyn Navy Yard, and was an instructor in kinematics for the U. S. Army at Manhattan College. He is a graduate of New York University.

◆

Dr. Francis C. Frary has retired as director of research for Aluminum Co. of America and is succeeded by **Dr. Kent R. Van Horn**. Dr. Frary, called the founder of organized research in the aluminum industry, joined Alcoa in 1918. He organized Aluminum Research Laboratories at New Kensington, Pa., which under his leadership became one of the world's foremost industrial metallurgical research institutions. He holds more than 30 U. S. patents and is author and co-author of numerous books and papers on metallurgical and chemical subjects. Dr. Van Horn, a veteran of 22 years with Alcoa, advances from the position of associate research director. He is widely known for his articles in technical publications, is co-author of a textbook on metallurgy, and has another book scheduled for publication this year. He came to the company in 1929 as a research metallurgist at the Cleveland division of the Aluminum Research Laboratories and became assistant manager of this division in 1944. A year later he was advanced to chief of the division and in 1949 was made assistant director of research in Cleveland, from which position he was transferred to the New Kensington headquarters.

◆

L. E. Lentz

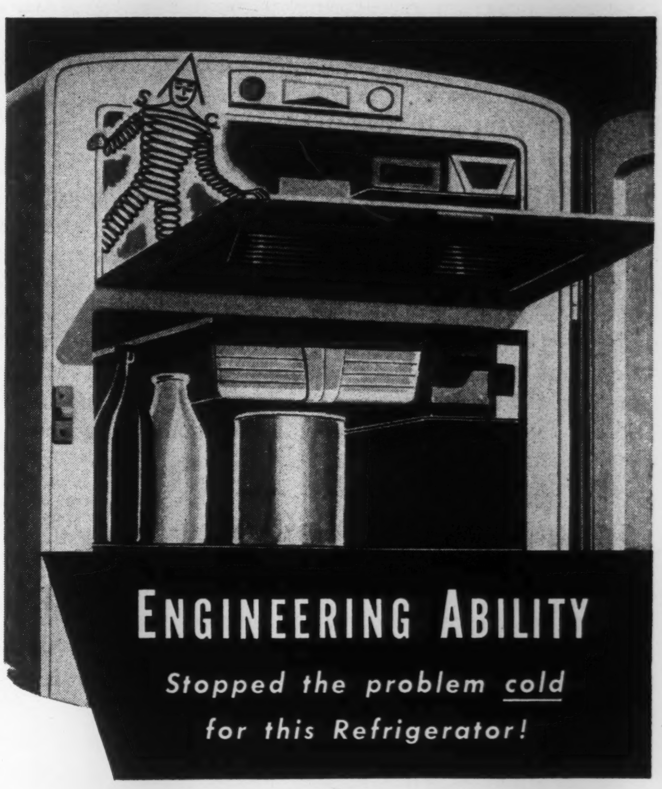
L. E. Lentz, vice president of Underwood Corp., New York, has been named to direct all research, experimental and development engineering for the company. Formerly assistant superintendent of the General Vehicle Co. of Long Island City, N. Y., Mr. Lentz joined the Elliott-Fisher Co. at Harrisburg, Pa., as service manager in 1918 and was advanced to vice president of that company five years later. When the Elliott-Fisher and Underwood Typewriter companies were consolidated in 1928, Mr. Lentz was transferred to New York. He has served as a vice president of Underwood Corp. since 1931.

◆

Justus B. Stevens has been appointed vice president and chief engineer for Sealol Corp., Providence, R. I. Mr. Stevens joined the company as a draftsman-engineer. Recently he has had responsibility for the design and development of mechanical rotary shaft seals and has assisted in the application of Sealol seals in products such as pumps, gear boxes, speed reducers, aircraft gas turbine engines, etc. Working with Mr. Stevens is **Kenneth Bell,** recently appointed assistant chief engineer.

◆

Announcement has been made of the appointment of **Dr. Lauriston C. Marshall** as director of Link-Belt Company's new Physical Testing and Research Laboratory at Indianapolis. He will be responsible for an



. . . with Springs by Automatic Spring Coiling Co.

The need was very specific—

"Give us a spring," this refrigerator manufacturer requested, "that can THINK . . . so to speak. We have an evaporator door to the cold chest compartment that must respond to the touch of a finger, swing open to a certain angle, and stop there. It should also be possible to close the door with a nudge of a food-burdened housewife's elbow."

So . . . Automatic Spring Coiling Co. was called in and *Engineering Ability* came through!

The answer . . . calculated by our engineers was to design a spring with precisely the right *build-up,* with just the right combination of spring and wire diameter. In this way, not only would the spring do the required job—metering out its energy at the right rate—but also tolerances would be such that production could be handled with facility on our high speed equipment.

Put Automatic Spring Coiling Co. to work on *your* spring problem. See how members of our entire organization — consultants, designers, sample-makers, inspectors—swing into operation and *click.* Working as a well-integrated team with strict adherence to Quality Control we pledge ourselves to bring you the finest, most dependable springs to insure the successful and efficient performance of your product.

Our veteran consulting engineers are ready to survey your requirements without obligation. Please write.

AUTOMATIC SPRING COILING CO.
4043 West Thorndale Avenue
CHICAGO 30, ILLINOIS

extensive program of original research, as well as for continuing investigation into ways and means of improving production methods and the quality of conveyor and power transmission products developed by the company's 16 manufacturing plants.

◆

Artisan Metal Works Co., Cleveland, has appointed **Fred A. Montgomery** as chief engineer. Mr. Montgomery was most recently in charge of engineering at the Bunell Machine & Tool Co., Cleveland, where he directed the building of special machinery and machine tools. He has done special design and development work for the Gabriel Co., Osborn Mfg. Co., Van Dorn Iron Works, Breckenridge Machine Co., and for twelve years headed his own consulting engineering and design concern.

◆

The appointment of **John Waldherr Jr.** to the position of director of engineering has been announced by the Chefford Master Mfg. Co. Inc. of Fairfield, Ill. Mr. Waldherr will direct all engineering activities related to the company's automotive products and Ordnance contracts. He joined the company in 1947 and has served as chief design engineer since 1949.

◆

Dr. William A. Thomas has joined the engineering staff of The Electric Products Co., Cleveland. He has served in the engineering department of General Electric Co. and as an electrical engineer with E. I. du Pont de Nemours & Co. Inc.

Formerly chief engineer of Harrison Radiator Division of General Motors Corp., **Laurence P. Saunders** has joined Bell Aircraft Corp., Buffalo, as a chief administrative engineer.

◆

The Oliver Corp. has appointed **T. H. Morrell** chief engineer at its Charles City, Iowa, plant to succeed the late **Louis A. Gilmer.** Also, **P. Y. Burns** was made assistant chief engineer and is replaced as supervisor of experimental engineering by **Homer Dommel.**

◆

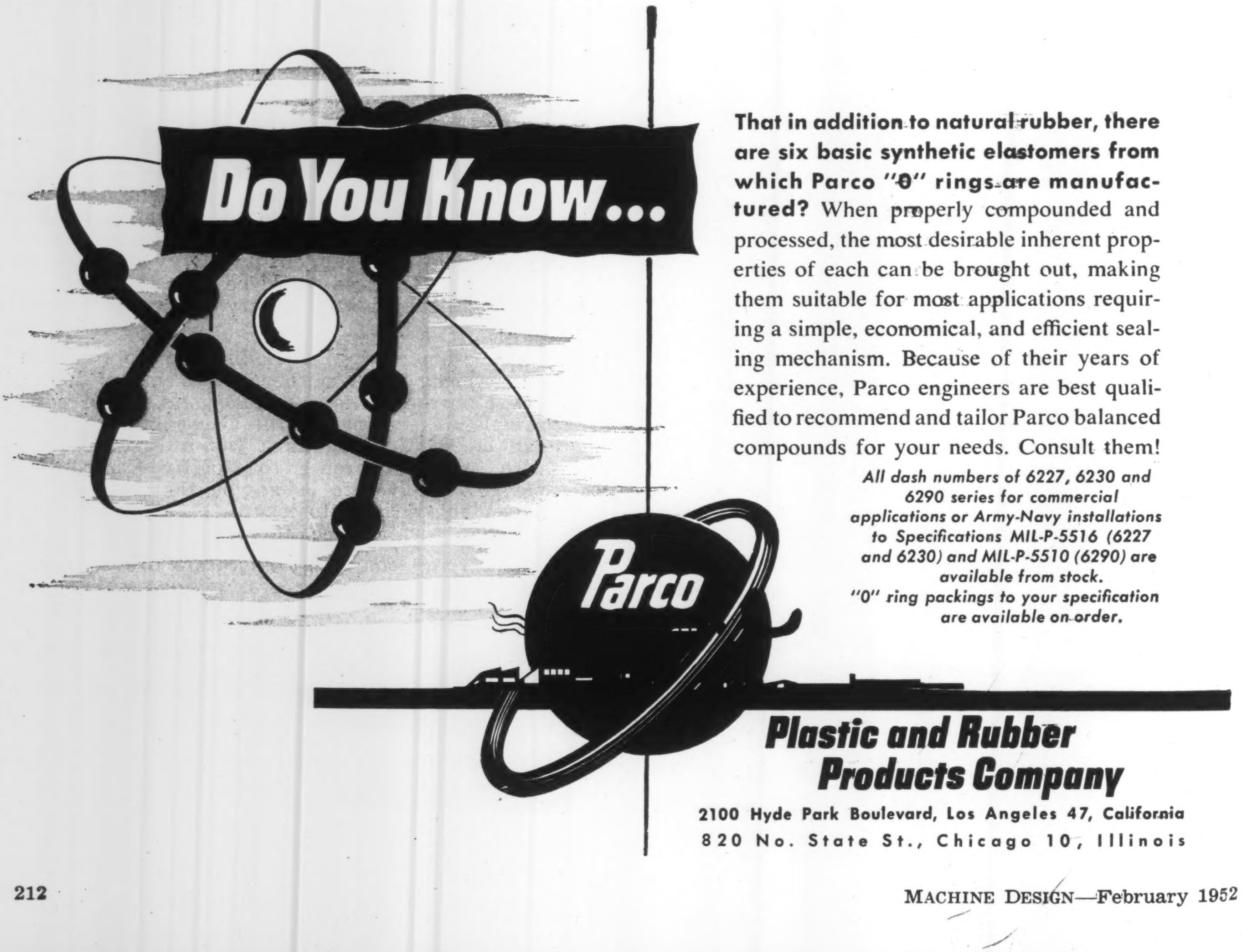
Raymond L. Carey is now assistant chief engineer for Taylor-Wilson Mfg. Co., Pittsburgh. He was formerly tube mill engineer of Jones & Laughlin Steel Corp. at Aliquippa, Pa.

◆

Magnetic Metals Co., Camden, N.J., has appointed **Dr. A. W. Friend** as director of engineering and development. Dr. Friend comes to his new position from the instrument division of Daystrom Inc., where as director of engineering he has been developing radar gun fire control apparatus.

◆

Vernon N. Ferguson, assistant chief industrial engineer for the Texas Division of North American Aviation Inc. during World War II and more recently on the faculties of the University of Kansas and the University of Texas, has been appointed chief industrial engineer of Texas Engineering and Manufacturing Co. Inc., Dallas, Tex.



That in addition to natural rubber, there are six basic synthetic elastomers from which Parco "O" rings are manufactured? When properly compounded and processed, the most desirable inherent properties of each can be brought out, making them suitable for most applications requiring a simple, economical, and efficient sealing mechanism. Because of their years of experience, Parco engineers are best qualified to recommend and tailor Parco balanced compounds for your needs. Consult them!

All dash numbers of 6227, 6230 and 6290 series for commercial applications or Army-Navy installations to Specifications MIL-P-5516 (6227 and 6230) and MIL-P-5510 (6290) are available from stock. "O" ring packings to your specification are available on order.

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G.P.&F.
DEFENSE DIVISION
MILWAUKEE

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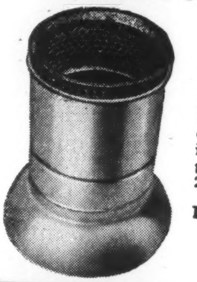
Over a period of many years, Geuder, Paeschke & Frey Co., has produced many stampings for both civilian and military products. The items range from simple to highly intricate designs and demonstrate our technical efficiency and modern facilities. Illustrated here are a few of the many sub-contract jobs we have made for the government orders of our customers.

AUGMENT YOUR PRODUCTION FACILITIES with G. P. & F. service. If you have a metal fabrication problem that's outside your field or beyond your plant facilities, submit blueprints or ideas to us. We can do your work from fabricating and finishing to final assembly.

TRANSMITTER CASE AND COVER

18 B & S Ga. Aluminum
Seamless Drawn
Brazed to die cast frame
Length—15¾" Width—9¾" Height of Case—5"

HOUSING FOR INDUSTRIAL VACUUM CLEANER



Seamless drawn base welded to electrically welded body. Seamless drawn perforated insert is hot dip galvanized 18 and 20 U.S. Ga. Steel. Height—20". Diameter of base—18½".

RADIO RECEIVER CASE

Seamless Drawn Steel
Reinforced Cover and Case
Length—17" Width—10"
Height—6½"

STAMPING • DRAWING
FORMING • TINNING
GALVANIZING • WELDING
VITREOUS ENAMELING
SPRAY FINISHING
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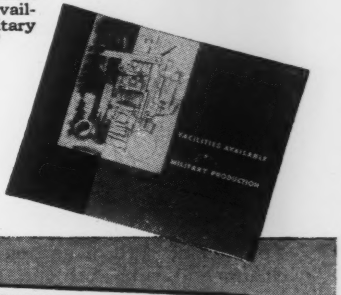
Here's a fast way to find out how G. P. & F. can help YOU on your defense orders. Send for new booklet: "Facilities Available for Military Production."



ELECTRIC LIGHT HOOD

Seamless Drawn Steel—16 U.S. Ga.
Height—7½"
Diameter—6½"

AERIAL DELIVERY CONTAINER

Aluminum
Length—26"
Height—7¾"
Width—7¾"

TRANSMITTER CASE

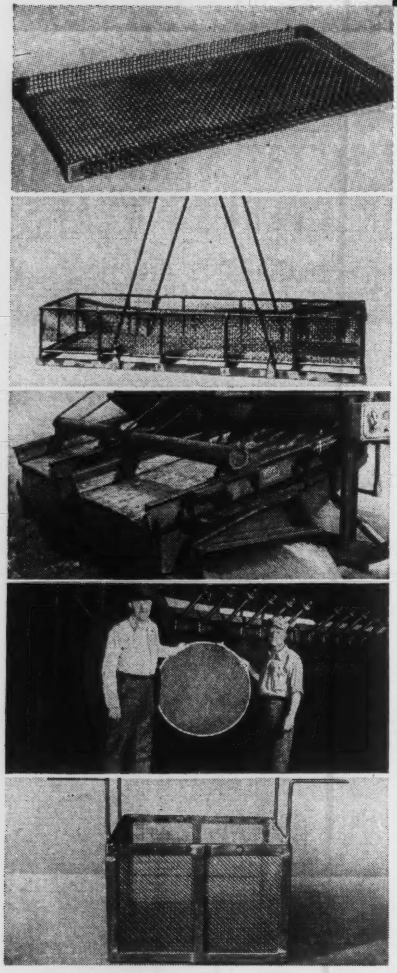
14 B & S Ga. Aluminum brazed to die cast ring—Seamless Drawn
Length—10¾" Width—9½" Height—8¼"

15 Acres of Production Facilities . . . Complete Tool and Die Department

GEUDER, PAESCHKE & FREY CO. • [illegible] WEST ST. PAUL AVE. • MILWAUKEE [illegible]

What type of
CUSTOM BUILT WIRE CLOTH PARTS
do you need

?



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With more than 30 years experience in this field, we can work from your own prints . . . or, if none are available our design engineers will draw up prints based on your description of the job the part must do.

Our newly expanded production facilities include equipment for cutting, forming, bending, shaping and welding of any metal or alloy in sheet, rod, or wire cloth form . . . as well as our large battery of wire cloth looms.

Tell us your needs. Let us tell you how economically and quickly we can fill them. Write direct or call your Cambridge field engineer. Look under "Baskets-Wire" in your classified telephone directory.

The Cambridge Wire Cloth Co.
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THE ENGINEER'S Library

Quality-Control Handbook

Edited by J. M. Juran, consulting management engineer; published by McGraw-Hill Book Co., New York; 800 pages, 6 by 9 inches, clothbound; available from MACHINE DESIGN, *$10.00 postpaid.*

This is the first comprehensive handbook in the field of quality control. Containing fifteen chapters by ten contributors, it is divided into two sections. The first, nine chapters long, explains the universal principles, techniques and methods of quality control. The second, with six chapters applies these principles to particular processes.

Economic considerations are reviewed first, followed by a discussion of the methods for specifying quality. A long chapter presents methods for organizing a quality-control program in a manufacturing plant. Acceptance (the passing or rejecting function of the inspection department) and assurance (overseeing and checking quality-control procedures) are then reviewed. Rounding out the first section of the book, the next two chapters—some 160 pages in length—cover statistical methods and paper work, with a final chapter on applications of electric accounting machines to quality-control procedures.

Specific applications of quality control are described for seven types of operation; textile production, chemical processing, aircraft manufacturing, electron-tube manufacturing, inspection sampling of incoming parts, and screw-machine operations.

□ □ □

Theory of Elasticity

Second edition by S. Timoshenko and J. N. Goodier, professors of engineering mechanics, Stanford University; published by McGraw-Hill Book Co., New York; 506 pages, 6 by 9 inches, clothbound; available from MACHINE DESIGN, *$9.50 postpaid.*

Having the same basic arrangement as the first edition, published in 1934, this volume has been revised to include new developments and clarifications in the theory of elasticity and its applications. Former brief treatments of the photoelastic method, two-dimensional problems in curvilinear co-ordinates, and thermal stress have been expanded to separate full chapters. New material and information deal with the theory of the strain-gage rosette, gravity stresses, Saint-Venant's principle, components of rotation, and the reciprocal theorem. Also covered are general equation solutions, the approximate character of plane stress solutions, center of twist and center of shear, torsional stress concentration at fillets, the approximate treatment of slender sections in torsion and bending, and the circular cylinder with a band of pressure. An appendix on the method of finite differences and its applications has been added.

□ □ □

Helicopter Analysis

By Alexander A. Nikolsky, professor, Princeton University; published by John Wiley & Sons Inc., New York; 340 pages, 5¾ by 9 inches, clothbound; available from MACHINE DESIGN, *$6.50 postpaid.*

A general physical picture of helicopter theory and a possible approach to the analysis of some of the basic helicopter problems are covered in this book. Parts of the book represent original analyses by the author—mainly in dynamic stability and control; the rest is an interpretation of previous work. Simplifications and assumptions have been made where helicopter theory, rapidly expanding, has left uncertain areas. These assumptions and simplifications, based on the author's research experience in helicopter design and analysis, are clearly marked.

The first four chapters cover steady vertical and forward flight, the subjects being: a review of air screw theory; the helicopter in steady vertical flight; hinges, flapping, and feathering systems; and forward flight. Dynamic stability and control response are studied in the next three chapters for the general case, for hovering flight and, longitudinally, for a laterally stabilized helicopter with articulated blades in forward flight. A chapter on elastic analysis of rotor blades completes the book.

Association Publications

NACA Technical Series: Each of these reports is 8 by 10½ inches in size, paper-bound and side-stapled, and contains complete drawings and illustrations. The following Technical Notes are available:

2449. Investigation of influence of chemical composition on forged modified low-carbon N-155 alloys in solution-treated and aged condition as related to rupture properties at 1200 F—111 pages

2472. Fundamental effects of cold working on creep properties of low-carbon N-155 alloy—45 pages

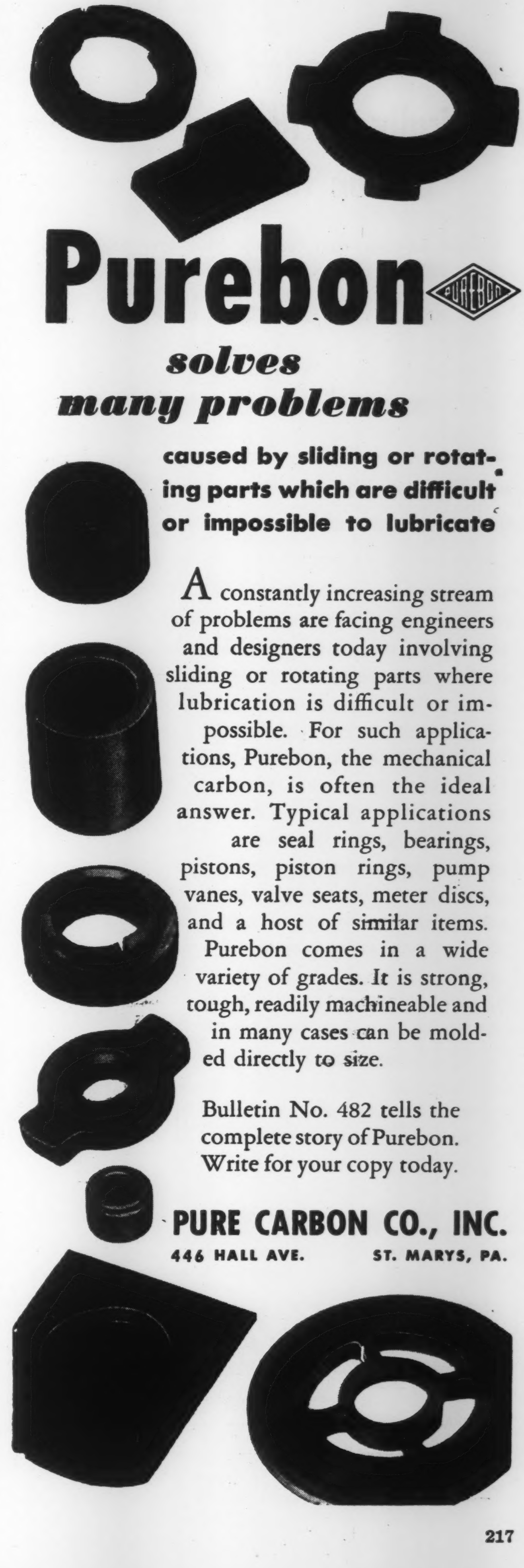
2538. Mechanical and corrosion tests of spot-welded aluminum alloys—74 pages

2586. Fundamental effects of cold-work on some cobalt-chromium-nickel-iron - base - creep-resistant alloys—12 pages

Additionally, the following Technical Memorandum is available:

1322. Theory of thin-walled rods (Translated from *Prikladnaya Matematika i Mekhanika,* v. 13, Nov.-Dec. 1949, p. 561-596)—53 pages.

Copies of these reports may be obtained from National Advisory Committee for Aeronautics, 1924 F St,. Washington 25, D. C.



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caused by sliding or rotating parts which are difficult or impossible to lubricate

A constantly increasing stream of problems are facing engineers and designers today involving sliding or rotating parts where lubrication is difficult or impossible. For such applications, Purebon, the mechanical carbon, is often the ideal answer. Typical applications are seal rings, bearings, pistons, piston rings, pump vanes, valve seats, meter discs, and a host of similar items. Purebon comes in a wide variety of grades. It is strong, tough, readily machineable and in many cases can be molded directly to size.

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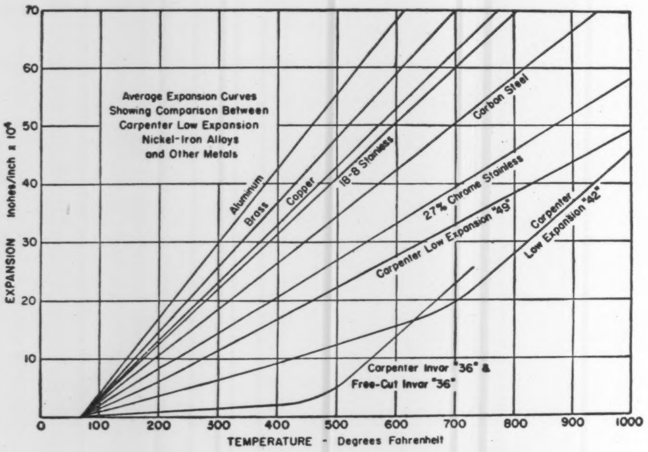
An alloy with practically no thermal expansion up to 400°F

Note in the graph how the low thermal expansion rate of Carpenter Invar "36" compares with other metals. The free-machining alloy, Carpenter Free-Cut Invar "36", has the same low expansion characteristics and simplifies production of machined parts.

Where the operation of precision instruments or machines is affected by temperature variations, the low expansion of this alloy helps to insure constant accuracy. Another important use is in automatic on-and-off controls, such as thermostats. These controls are operated by the difference between invar's low expansion rate and that of a high expansion metal.



For detailed engineering data on the Carpenter Invar "36" alloys, write for a copy of the Carpenter Low Expansion Alloy book. It contains 23 pages of data on expansion and mechanical properties, physical constants, etc.

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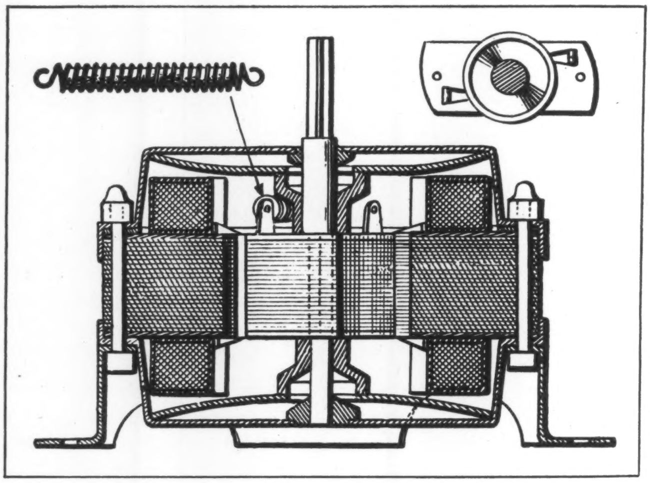
NOTEWORTHY Patents

Felt-cored springs in a rotary electromagnetic relay serve to absorb shock and vibration, thereby prolonging service-free life of the unit. Spring vibrations are effectively damped out by cylindrical felt inserts within the extension springs which reset the armature. Peripheral surfaces of the armature are contour-ground, receding at the rate of 0.001 inch per degree, to equalize the torque developed throughout 45-degrees rotation. To reduce the possibility of a-c hum and possible failure to reset because of residual magnetism, contacting surfaces of the rotor and stator are crowned and chrome-plated. Copper shading coils are also employed to obviate tendency toward hum or chatter in the unit which is designed for actuating electrical switches, control valves, mechanical devices, etc. The armature shaft thrust bearings of the device are supported by dished metallic thrust plates inside the end-bells. These shock-plates resist damaging effect usually incurred by shock loading. Patent No. 2,563,271 assigned to Magnetic Devices Inc. by Osborne I. Price.

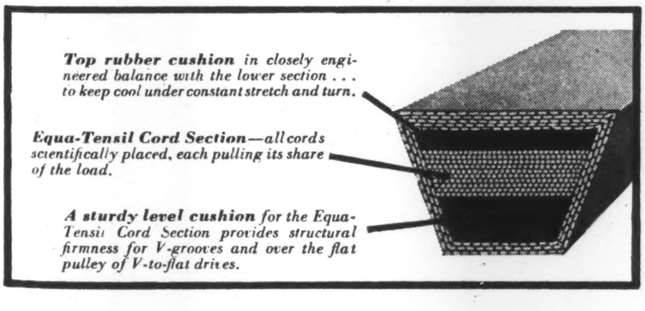


Revolving cylinder barrel in a reciprocating pump eliminates the usual valves and timing mechanism employed in piston type pumps. The multiple-cylinder barrel containing opposed pistons is ball bearing mounted in the main body of the pump to offset side pressure forces. Pumping action through individual cylinder ports is induced by the approach and recession of the spring separated pistons as they are carried between two canted thrust bearings. Rotary valving action is effected by sealing lands between the inlet and outlet cores in the central section of the pump body. One of the thrust bearings may be shifted 180 degrees to cancel pumping action without stopping pump rotation. The

Prepared for
Special Work
US
RAINBOW
V-BELT

NATURALLY every U. S. Rubber V-Belt has special properties, depending on its ultimate purpose.

But if a belt has to handle conditions not usually found on the average drive, then it has to be "prepared" for that job. If an oil condition is involved, the belt may be made with an oil-resistant cover, or, if the condition is extreme, the entire belt may be made of oil-proof construction.


***Top rubber cushion** in closely engineered balance with the lower section . . . to keep cool under constant stretch and turn.*
***Equa-Tensil Cord Section**—all cords scientifically placed, each pulling its share of the load.*
***A sturdy level cushion** for the Equa-Tensil Cord Section provides structural firmness for V-grooves and over the flat pulley of V-to-flat drives.*

Where generation of static electricity occurs, the V-belt is so compounded that it becomes a conductor of electricity.

Only U. S. Rubber gives you *all* of these 4 V-Belt advantages:

1. *Major part of inherent stretch worked out by mechanical means, yet enough elasticity is retained to allow belt to withstand severe shock loads.*
2. *Cords treated with latex, to reduce heat generated by constant flexing, and to get maximum adhesion between the component parts of the belt.*
3. *Protective jacket that increases grip while keeping out dirt and prolonging wear.*
4. *Unique Equa-Tensil Cord Section—exclusive with U. S. Rubber—which provides efficient pull and strength under diverse operations.*

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MULTIPLE V-BELTS

F. H. P. BELTS • FAN BELTS

SPECIAL PURPOSE BELTS

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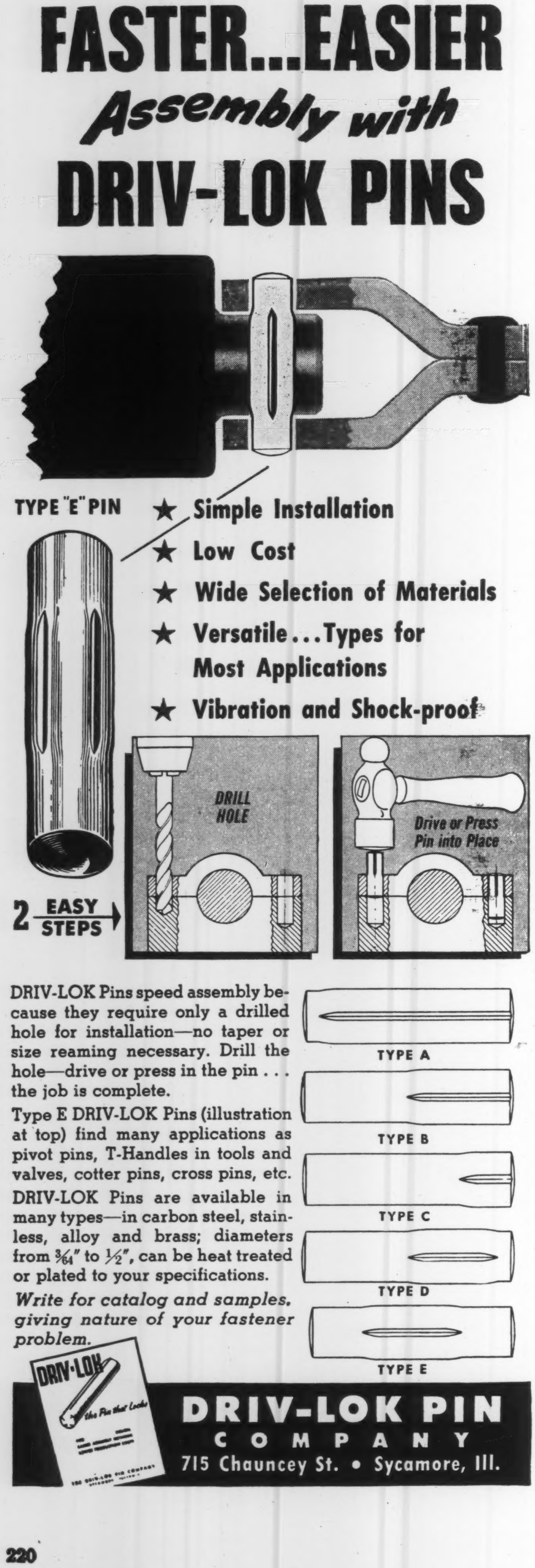
FASTER...EASIER
Assembly with
DRIV-LOK PINS

TYPE "E" PIN

- ★ Simple Installation
- ★ Low Cost
- ★ Wide Selection of Materials
- ★ Versatile...Types for Most Applications
- ★ Vibration and Shock-proof

2 EASY STEPS

DRILL HOLE

Drive or Press Pin into Place

DRIV-LOK Pins speed assembly because they require only a drilled hole for installation—no taper or size reaming necessary. Drill the hole—drive or press in the pin . . . the job is complete.

Type E DRIV-LOK Pins (illustration at top) find many applications as pivot pins, T-Handles in tools and valves, cotter pins, cross pins, etc.

DRIV-LOK Pins are available in many types—in carbon steel, stainless, alloy and brass; diameters from 3/64" to 1/2", can be heat treated or plated to your specifications.

Write for catalog and samples, giving nature of your fastener problem.

TYPE A

TYPE B

TYPE C

TYPE D

TYPE E

DRIV-LOK PIN COMPANY
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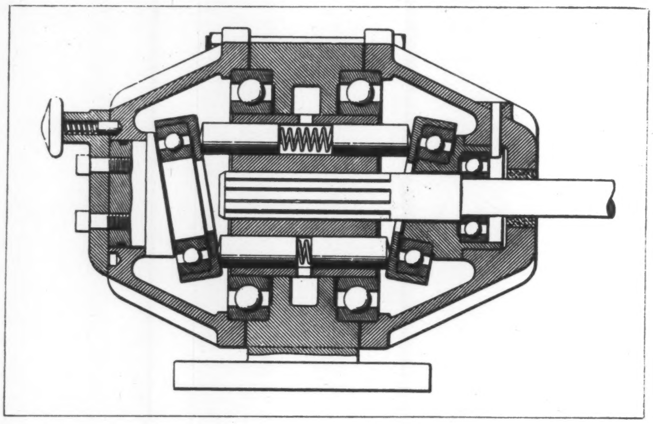
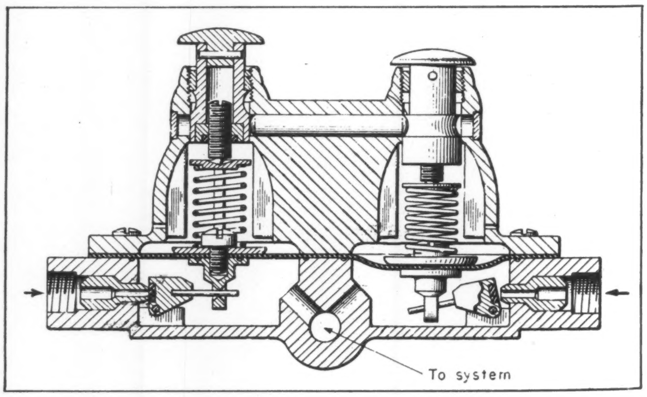


pump may be converted for reverse rotation by removing the body bolts and relocating the shaft-end housing and bearing assembly 180 degrees around. To do this, it is not necessary to remove or change any of the internal parts. Patent 2,565,582 assigned to Be-Ge Mfg. Co. by John A. White, Jr.

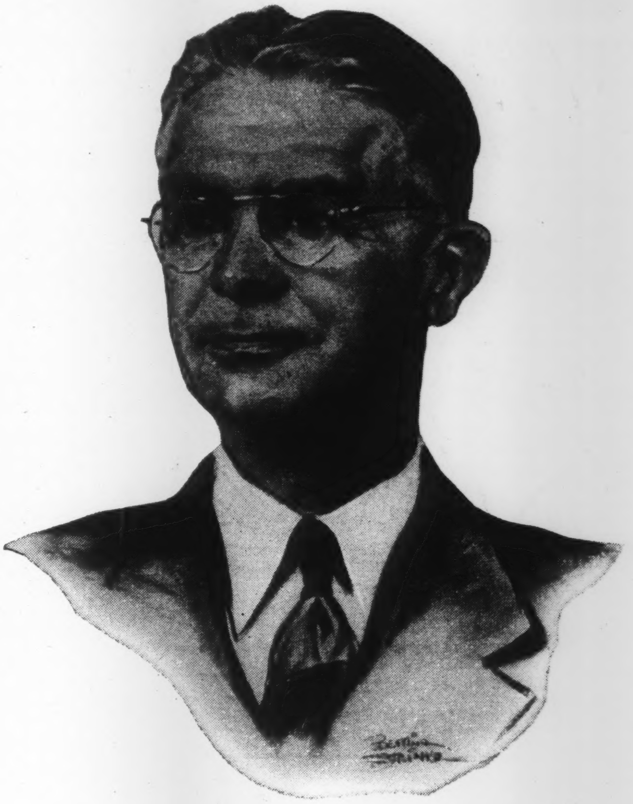
FLOATING INTERLOCK PIN effectively insures alternate positioning of pushbuttons in a diaphragm gas control valve. Located in a crosshole between the pushbutton stems, the pin is slightly longer than the distance between the stem guide holes. One end of the pin is held in a radiused groove of the depressed pushbutton stem by the other end being in contact with a straight stem portion of the released pushbutton. Difference in compressed length of the diaphragm control springs, as determined by the pushbutton positions, permits one of two sources of gas supply to become depleted to a predetermined pressure before the reserve supply automatically feeds into the system. Manual operation of the protruding pushbutton reverses the valve status without disrupting service and the discharged bottle may then be replaced by a full one without interruption of service or loss of gas from the system. Patent 2,518,894 assigned to Union Carbide and Carbon Corp. by Frank F. Humbarger, Ralph C. Pierson, and Willis G. Schepman.

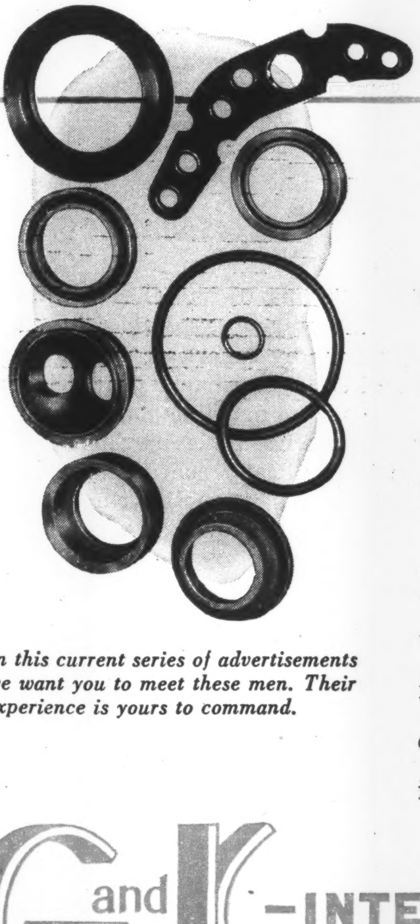


Complete printed copies of all patents are available from the Commissioner of Patents, Washington 25, D. C., for 25 cents each.

Meet Everett H. Clark
General Manager
International Packings Corporation
Affiliated with Graton & Knight Company

Educated at Worcester Polytechnic Institute, Mr. Clark met his first packings problems as a designer and manufacturer of precision instruments. With Graton & Knight Company since 1935, he has been factory worker, foreman, sales correspondent, sales engineer, sales manager and finally General Manager of the Packings Division. He wrote the 320-page Graton & Knight Packings Manual, which has been adopted as a text book in many of the technical schools and colleges. A member of the Standards Committee of the American Leather Belting Association, he is now at work on the standardization and simplification of packings through the Joint Industry Conference.





In this current series of advertisements we want you to meet these men. Their experience is yours to command.

There's a personal side to every packings problem

It lies beyond the Dash number, with its dimensions. It involves questions relating to fluid: its pressure and temperature range; to apparatus: its function, metals and finishes . . .

At G&K-INTERNATIONAL your answers to these questions receive the personal attention of men who have lived and worked with packings applications for many years. Their experience in leather and impregnants, in basic rubbers and compounds, in design and manufacture . . . all are summed up for you in packings that meet *your* needs exactly.

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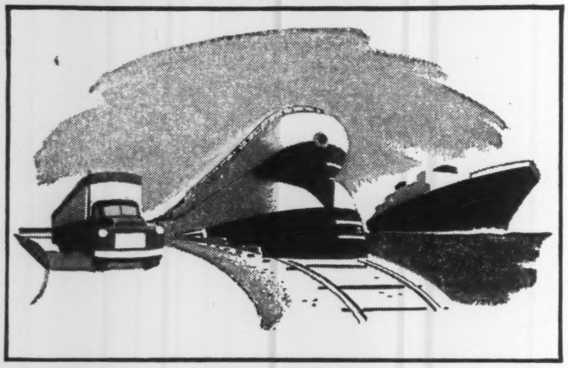
Bendix-Skinner

ORIGINATOR OF **MICRONIC** FILTRATION

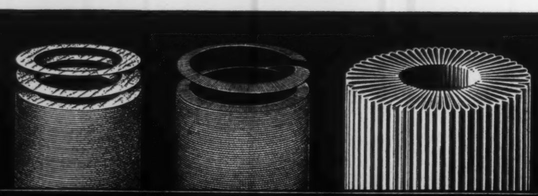
the Finest

Answer to Any Filtering Problem



For over twenty years **Bendix-Skinner** has specialized in solving the filtering problems that "couldn't be done." From this experience has come entirely new and exclusive filtering techniques which do even the work-a-day filtering jobs better and at lower long-range cost. Tell us about *your* problem—nine times out of ten **Bendix-Skinner** filters will supply the "finest" answer.

***Over 350 Models** providing filtration from ½ micron (.000019") upwards at flow rates from 1 to 5000 g.p.m.*



SKINNER PURIFIERS DIVISION OF Bendix AVIATION CORPORATION

1503 TROMBLY AVENUE,
DETROIT 11, MICHIGAN

Export Sales: Bendix International Division, 72 Fifth Ave., N. Y. 11, N. Y.

Protective Finishes

(Concluded from Page 145)

to do and also to prescribe the result.

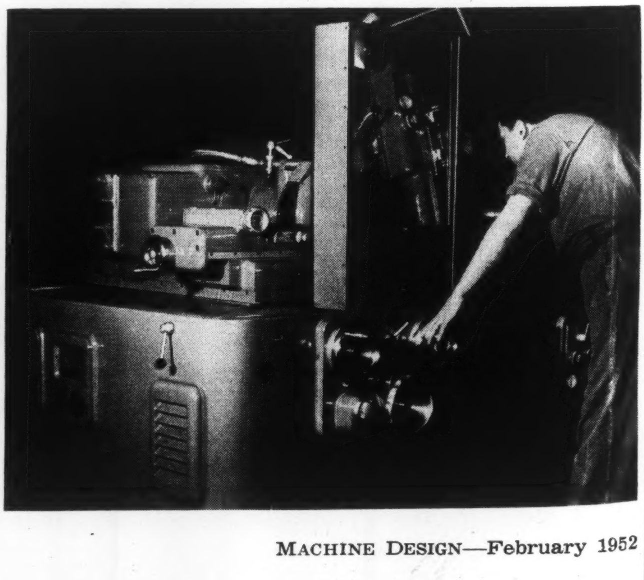
Design engineers should be conversant with Government finish specifications, the types of coating available, and the principal objectives of the various phosphate coatings. It would be profitable, too, to study different types of equipment in the field after years of service to determine inherent weaknesses—areas where chemical and mechanical failures are most certain to be found.

The production of any equipment, civilian or military, necessitates careful design if it is to have an adequate, trouble-free life. This is especially true of both decorative and protective finishes. To determine the optimum finish, the conditions under which the product is to operate must be clearly understood and the final choice made to obtain the best combination of properties.

Design considerations, when military products are involved should include: Familiarity with the pertinent finish specifications; the choice and application of the required protective phosphate finish; the choice and application of the required paint system; the inclusion of holes for adequate drainage and the avoidance of trapping areas which would cause the formation of moisture through direct leakage or condensation; and the installation of adequate equipment to do the protective finishing job.

Grinds Precision Gears

PRECISION grinding of hardened gears for printing presses, requiring exceptionally close tolerances, is being done by American Type Founders Inc. on the imported Swiss Reishauer gear grinder shown. Electrical drive of the machine comprises seven synchronized motors, with table movements, feed and work centers hydraulically controlled. Cutting lubricant is kept clean by a magnetic drum which collects and removes steel grindings.



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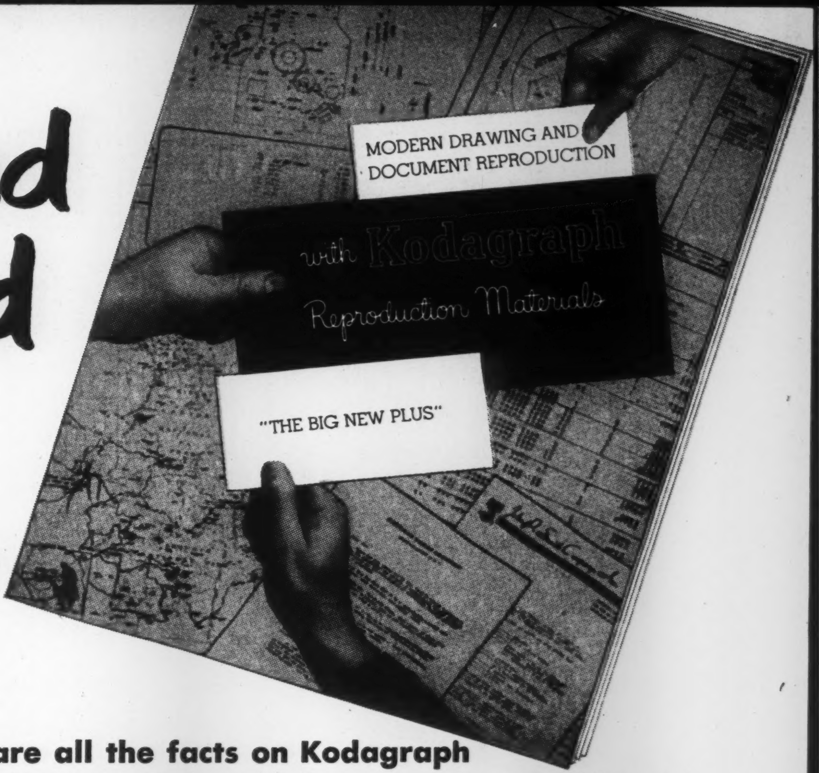

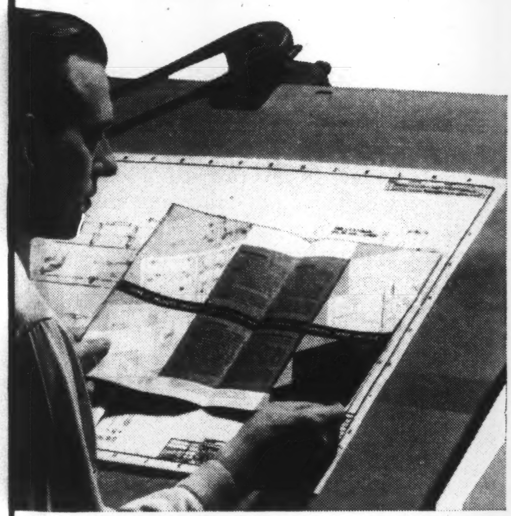

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☐ Bulletin 349 on Salvage and Service

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1549

REPORT ON

Materials

PRODUCTION records—and continued shortages—are still the general pattern of the materials picture. Steel production for 1951 was a record 105 million tons, the first time that steel production has ever exceeded the 100-million-ton mark. Aluminum production was almost 17 per cent above the 1950 figure. Nickel's increase was 10 per cent.

Despite these increases, a "stabilized pattern at previous levels" continues, according to the National Production Authority. In other words, current shortages are destined to stay with us for a while. Metals in tightest supply are copper, nickel, cobalt, tin and lead. Cold-rolled steel strip, however, is in fair to good supply, and light-weight alloy and malleable-iron castings have eased.

Among nonferrous metals, copper continues to be the most critical, with little relief expected. Industry's operating inventory of tin is very low. Zinc, nearly as short as copper; and lead, slightly better, still suffer as a result of trickling imports due to world prices.

Supplies of rubber and synthetic rubber have improved greatly, with only butyl remaining in the critical category.

The plastics raw-material supply situation, too, has improved considerably since a year ago. Although military applications for plastics have increased substantially, the current supply has increased, and future increases seem likely.

Many plastics are now in a balanced situation, with supply meeting the current demand. Thus, the phenolics, ureas, cellulose acetate and butyrate, the acrylics, polystyrene, the vinyls, and nylon (plastic type) all seem adequate. Ethyl cellulose, melamine and the polyesters are in adequate supply, but future military requirements may alter this situation. Polyethylene is still in short supply, but increased production is expected to relieve this condition to some extent.

Call for Relief

Many materials producers are beginning to ask for a relaxation of materials controls. Thus, Richard F. Sentner, assistant executive vice president of U. S. Steel Corp., favors termination of present steel controls as soon as possible, with an interim program to take care of the transition period. H. E. Humphreys Jr., presi dent of U. S. Rubber wants a completely free market, claiming that the rubber stock-pile is now more than adequate, that certain kinds of synthetic rubber are already in surplus supply, and that there is a glut of natural latex.

Even though the possibilities are slight that materials controls will be terminated completely in the near future, production facilities for many raw materials are being rapidly expanded—a sure sign that materials controls will be relaxed if no drastic increase is needed for the defense effort.

The aluminum industry, for example, has at present a capacity of 1743 million pounds per year. During 1952, facilities for producing 847 million pounds will be added. In 1953 this figure will again be upped by 428 million pounds.

By 1954 the Canadian nickel industry (which produces more than 90 per cent of the free world's total supply) will raise production figures 30 per cent over pre-Korea levels.

Annual steel capacity is now about 108 million tons. By July 1 it will be 113.5 million tons. By the end of the year it will be 118 million tons. And by the end of 1953, considering presently planned expansion only, it will be 120 million tons.

Other Side of the Picture

Despite the glimmer of light showing on the horizon, a few dark spots are evident. Over-the-ceiling contracts have been negotiated with operators of nine high-cost copper mines, a drastic move by which the Government subsidizes the mines in order to maintain their annual output of 16,000 tons. And release of Government-held surplus stocks of copper, lead, zinc and aluminum scrap was recently necessary to help make up the deficiency in industrial requirements.

So it appears that the calls for termination of certain controls will have to be considered by NPA—either this year or next—and it is certain that raw materials producing industries will continue their pressure.

CMP Regulation Amended

A wide range of revisions has been issued by the NPA in the Controlled Materials Plan Regulation No. 1, which sets forth the basic rules of CMP. Among the principal changes are a new definition of controlled materials, and a raise in the quantities of controlled materials which manufacturers of Class B products may self-certify in orders.

The new changes provide a consolidated regulation that incorporates all previous amendments as well as new changes. Previously CMP was an "open-end" operation, i.e., not all

where performance
of product or process
demands
dependable timing
specify
Cramer
time
delay
relay

Widely used in industrial controls for heat treating, for the control of plastic and injection molding, lapping, induction heating, mixing and agitation, purging gas fired ovens etc. — where accuracy of timing improves quality, reduces supervision or vitally protects the process or equipment itself — the Cramer Type TEC Time Delay Relay provides an adjustable time delay between the operation of a control circuit and the subsequent closing or opening of a load circuit. Designed for dependable, trouble-free service . . . compact construction . . . *extremely* accurate.

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We will gladly work closely with *you* on your dimensional gaging requirements, for the *quick* answer . . . the *right* answer. Bring your gaging problems to Federal and take advantage of our engineering experience. Send full details and blueprints to Federal Products Corporation, 1302 Eddy Street, Providence 1, R. I.

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manufacturers of products containing controlled materials were covered by its procedures. With the new changes, CMP now covers 100 per cent of manufactured products.

The new definition of controlled materials is designed to amplify and extend the previous definition, and is in accord with official interpretations previously rendered. It reads (italics represent changes or additions):

" 'Controlled material' means *domestic and imported* steel, copper, and aluminum, in the forms and shapes indicated in Schedule I of this regulation, *whether new, remelted, rerolled, or redrawn, including used and second quality materials, shearings, and material sorted or salvaged from scrap which are sold for other than remelting, rerolling or redrawing purposes.*"

In conjunction with the revised definition a number of steel, copper and aluminum materials were added to Schedule I (list of controlled materials). Items formerly included under several general headings are now defined more exactly. These revisions will go into effect with second-quarter allotments.

Smaller Users Self-Certify

Beginning with the second quarter, about 15,000 additional small users of controlled materials will be relieved of the necessity of filing CMP-4B applications for allotments of steel, copper and aluminum. Manufacturers of Class B products (as listed in the *Official CMP Class B Product List* of the NPA) will not be required to apply to NPA for metals to be used in the second quarter if their requirements *per quarter* are less than the following amounts:

Carbon steel	30 tons
Alloy steel	8 tons
Stainless steel	1500 lb
Copper and copper-base alloys	3000 lb
Aluminum	2000 lb

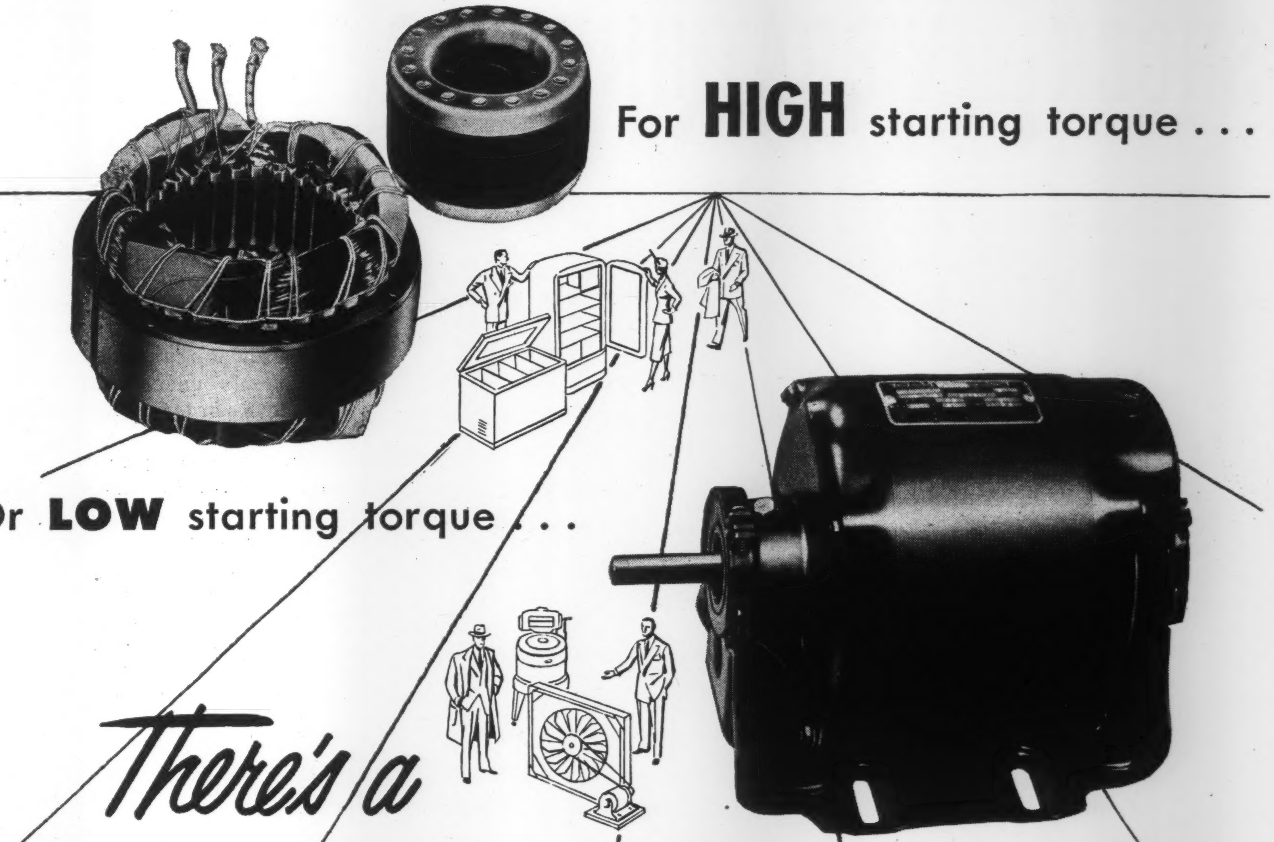
Previously the limits for self-certification were:

Carbon steel	5 tons
Alloy steel	½ ton
Stainless steel	none
Copper and copper-base alloys	500 lb
Aluminum	500 lb

Under the amended Regulation I, the manufacture of any product containing controlled materials is forbidden unless the manufacturer has an authorized production schedule.

Two more changes have been made worthy of attention. The first extends the period after expiration of a quarter during which a manufacturer may still accept a carry-over delivery of controlled materials from seven to 15 days. The second permits the use of a DO rating on orders for products or noncontrolled materials for delivery after the expiration of the quarter for which the related

For **HIGH** starting torque . . .



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DELCO FEATURES MAKE DELCO FINEST

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- Varnish-dipped and baked motor windings.
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Division of General Motors Corporation, Dayton, Ohio

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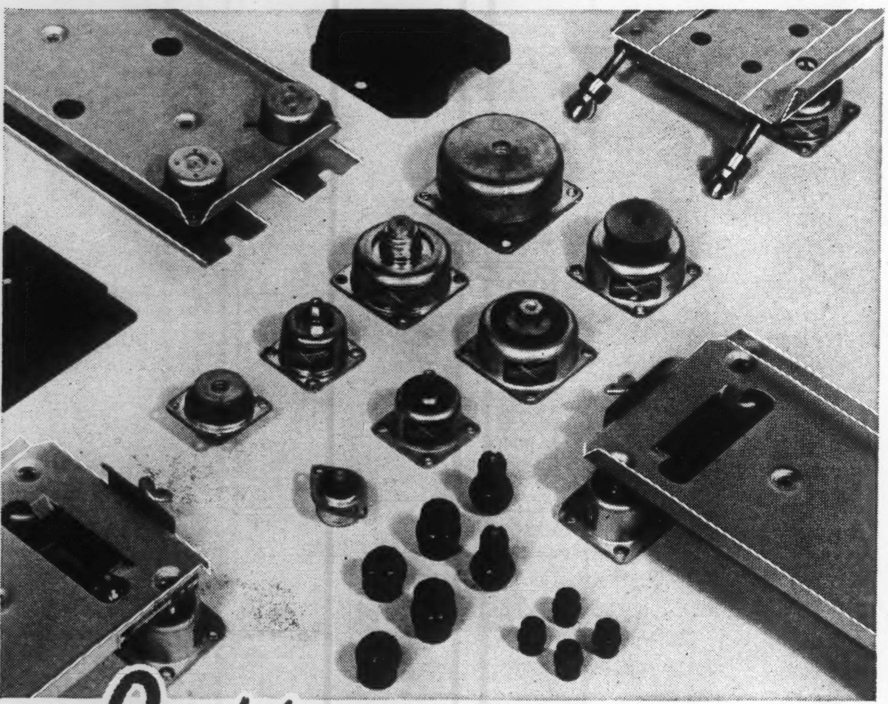
SHOCK and VIBRATION NEWS

BARRYMOUNTS FOR ASSURED CONTROL OF SHOCK AND VIBRATION



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allotment is valid. This second change is in recognition of the fact that lead-time factors sometimes make it necessary to receive noncontrolled materials or products later than the basic controlled materials.

Assistance in Placing CMP Orders

Manufacturers unable to place authorized controlled materials orders for steel, copper or aluminum will now be able to receive assistance from the NPA. The NPA's Metal and Minerals Bureau will help to see that allotments under CMP find a place as firm orders on producers' mill schedules.

Before coming to NPA for assistance, however, holders of CMP allotments must make every effort to place the orders themselves, and must be able to show that they have tried to place the orders with several suppliers without success.

If such an attempt is unsuccessful, the manufacturer may fill out NPA form 148, giving information needed to identify the particular tonnage involved. The form should then be forwarded to the appropriate person designated to render assistance. These people are:

Aluminum Products: Joseph Erwin, chief, Products Branch, Aluminum and Magnesium Division

Copper Brass-Mill Products: William L. Ashlock, chief, Production and Scheduling Section, Copper Division

Copper Wire-Mill Products: C. W. Ange, chief, Production and Facilities Section, Copper Division

Copper and Copper-Base Alloy Foundry Products: Walter Clark, chief, Facilities Section Copper Division

Steel Products: Frank T. McCue, assistant to the director, Iron and Steel Division.

Any of the above may be addressed care of the National Production Authority, Washington 25, D. C. Copies of Form 148 may be obtained from Department of Commerce field offices.

List of Basic Materials and Alternates

The NPA's latest list of basic and alternate materials (issued December 28, 1951) calls attention to the recent alternates suggested for some of the more critical materials. Steel and plastics are suggested instead of copper in nonfunctional, nonelectrical uses: printed circuits instead of wire in electrical devices. Coated or chrome-plated steel, or plastics, are suggested in place of brass plate. Name plates on machinery should be replaced by decalcomanias.

The following partial list supersedes the one published in MACHINE DESIGN, December, Page 210.

Metals—Group I-A
(In short supply)

a—Nonferrous:
*Aluminum

---

*Most critical.

WHO'S WHO

IN AIR AND HYDRAULICS

RIVETT DISTRIBUTORS are foremost authorities in applying air and hydraulic power. No group of distributors possesses more knowledge and experience about air and hydraulic power than these Rivett dealers. Most of the men in these organizations have spent their business lives working with air and hydraulics — designing circuits, recommending the correct types of valves and cylinders; and many have had a very practical background in the actual design and manufacture of most all components now being marketed.

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Newark and New York—Compressed Air Products, 1977 Springfield Ave., Maplewood, N. J.; 257 Greenwich St., New York City 7, New York

Philadelphia, Pa.—The Battersby Co., 3701 N. Broad Street

Boston, Mass.—L. W. Sheehy, 1104 Park Square Building

Baltimore, Md.—Colliflower, Incorporated, 5600-10 Old Frederic Road.

Pittsburgh, Pa.—F. R. Magill Co., 44 McKnight Street

Cleveland, Ohio—Garco Machy. Co., 21000 St. Clair Ave.

Dayton, Ohio—Seifreat-Elstad Machy. Co., P. O. Box 332

Cincinnati, Ohio—Seifreat-Elstad Machy. Co., P.O. Box 2508

Columbus, Ohio—Seifreat-Elstad Machy. Co., P. O. Box 922

Detroit, Mich.—Fors Sales Co., 2832 East Grand Blvd.

Flint, Mich.—Shively Bros., Inc., 719 East 2nd Avenue

Chicago and Milwaukee—MacMillin Engineering Corp., 1737 Howard St., Chicago 26, Illinois

St. Louis, Mo.—William Scheer Co., 6376 Clayton Road

Tulsa, Okla.—The Metallurgical Supply Co., P.O. Box 1652

Columbus, Ga.—Bunn H. Martin, P.O. Box 350

Minneapolis and St. Paul, Minn.—Anderson Machine Tool Co., 2641 University Ave., St. Paul 4, Minnesota

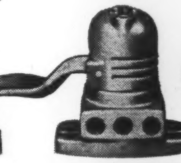
Los Angeles, Calif.—Machinery Sales Company, 2838 Leonis Boulevard.

San Francisco, Calif.—Ditzen Engineering and Sales, 5275 Claremont Ave., Oakland 9, Calif.

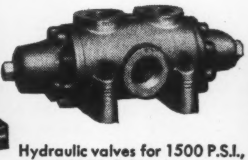
Oregon and Washington—Hydraulic Power Equipment Co., 2316 N.W. Savier Street, Portland, Ore.

Canada—D.M. Duncan Machinery Co., Ltd., 1958 Wyandotte St. East, Windsor, Ontario; 371 Bay St., Toronto

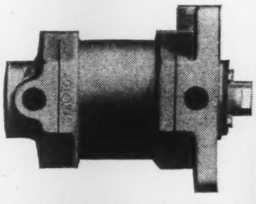
Air cylinders for 150 P.S.I.; seven mounting styles; nine bore diameters; strokes to 96"; cushioning.



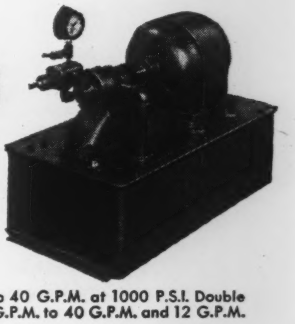
Air valves for 150 P.S.I.; five kinds of operation; ¼" to 1" sizes.



Hydraulic valves for 1500 P.S.I., up to 3000 P.S.I.; 4 types of action; 5 piston designs; 6 operations; ¼" to 1½".



Hydraulic cylinders for 300, 1500 and 3000 P.S.I.; 7 mountings; 10 diameters; strokes to 96"; standard and 2:1 rod; cushioning.



Power units .4 G.P.M. to 40 G.P.M. at 1000 P.S.I. Double units 3 G.P.M. and .4 G.P.M. to 40 G.P.M. and 12 G.P.M. at 1000 P.S.I.

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Rivett Furnishes a Complete Power Package — Valves, Cylinders, Power Units Air and Hydraulic. All sizes and types.

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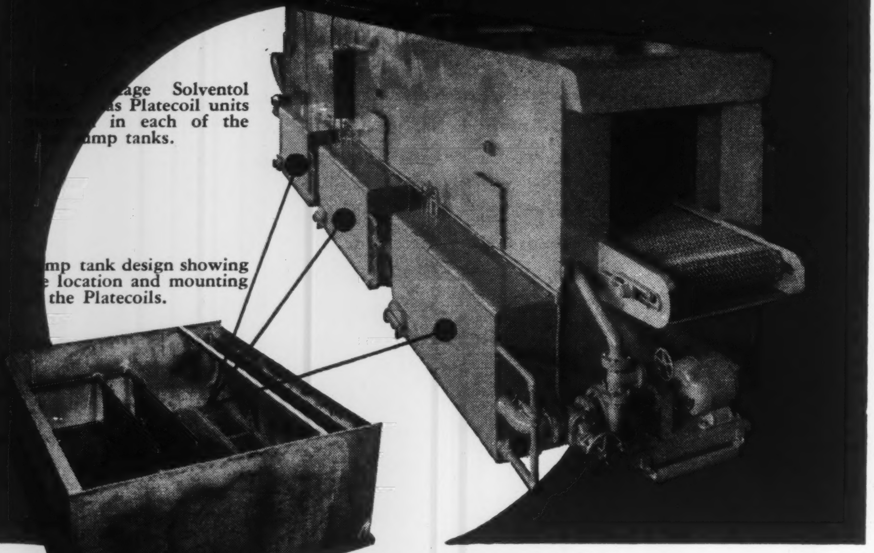

... realizes 6 major advantages

Solventol Chemical Products, Inc., Detroit, Michigan has joined the growing list of manufactures who are saving money by using Platecoils in their products. Use of Platecoils as the heating medium in their 3-stage washer has resulted in 6 major advantages:

1. *Simplified installation.*
2. *Sharply reduced installation costs.*
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4. *Low first cost.*
5. *Solution flow controlled without baffles.*
6. *Increased sales advantages due to easier maintenance.*

The Platecoils are installed in each of the three sump tanks as shown in the inset picture. The pre-fabricated Platecoil units are installed in but a fraction of the time required for bending and installing pipe coils. That's why most manufacturers find it costs less to buy and install Platecoils than to fabricate pipe coils in their own plant.

In addition, the Platecoils are about 50% more efficient than pipe coils. As a smaller size Platecoil can be used, considerable savings in steel and more compact machine designs are possible.

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LANSING 4, MICHIGAN

- *Beryllium
- *Copper
- *Lead
- Magnesium
- *Selenium
- Titanium
- *Tin
- *Zinc

b—Precious:

- Iridium
- Osmium
- *Platinum

c—Ferrous alloying elements:

- *Cobalt
- *Columbium
- *Molybdenum
- *Nickel
- *Tantalum
- *Tungsten

d—Ferrous:

- Bars, cold drawn:
  - *Alloy
  - Carbon steel
- Bars and semifinished, hot-rolled:
  - *Alloy
  - Carbon steel
- Castings:
  - Carbon steel
  - Gray iron: Heavy, over 3,000 pounds
  - Gray iron alloy: Heavy, over 3,000 pounds
  - Steel, low alloy:
    - Corrosive-resistant
    - *Heat-resistant
- Die blocks
- Forgings, heavy
- Iron powder
- Pig iron, low phosphorus
- Pipe:
  - Seamless, all sizes
  - Welded, 4 inches and over
- Plate, tin
- *Plates
- Rails
- Rope wire, galvanized
- *Shapes, structural
- Sheet, galvanized
- Strand wire, galvanized
- *Stainless steel: Nickel-bearing
- *Tubing, seamless:
  - Alloy mechanical
  - Alloy pressure
  - Carbon, mechanical
  - Carbon, pressure
- Wire, barbed
- Wire, drawn: welding quality

Metals—Group II-A
(In approximate balance)

a—Nonferrous:

- Antimony
- Bismuth
- Cadmium
- Calcium
- Germanium

b—Precious:

- None

c—Ferrous alloying elements:

- Chromium
- Manganese
- Vanadium

d—Ferrous:

- Forgings, medium
- Pipe welded: 3 inches and under
- Pig iron (other than in Group I)
- Sheet (except galvanized)
- Strip: Hot rolled
- Wire, drawn (except welding quality)

Metals—Group III-A
(In fair to good supply)

a—Nonferrous:

- Mercury

b—Precious:

- Gold
- Palladium
- Rhodium
- Silver

c—Ferrous alloying elements:

- Boron
- Tellurium
- Titanium (ferro)
- Zirconium

d—Ferrous:

- Castings:
  - Gray iron alloy, light-weights
  - Gray iron (light and intermediate weights)

Iron malleable
Forgings, small
Stainless steel: Straight chrome
Strip: Cold rolled
Tool steel
Tubing, welded: Carbon, mechanical

Chemicals—Group I-B
(In short supply)

Alkyl phenols
Alkyl polysulfide polymers
Butadiene
Phosphate plasticizers
Polyethylene resins
Polytetrafluorethylene (Teflon)
Selenium compounds
Styrene

Chemicals—Group II-B
(In approximate balance)

Alkyd resins
Carbon black
Melamine
Melamine resins
Nylon, plastic type
Phenolic resins
Polyvinyl acetate
Polyvinyl alcohol
Polyvinyl butyral
Polyester resins

Chemicals—Group III-B
(In fair to good supply)

Cellulose acetate
Cellulose butyrate
Ethyl cellulose
Methacrylate
Polystyrene
Polyvinyl chloride
Urea resins

Miscellaneous—Group I-E
(In short supply)

Asbestos:
  Chrysotile: Crude and spinning fibers
  Shingle and paper fibers
  Amosite
Graphite, natural:
  Crucible flake
  Ceylon: High carbon amorphous lump
Mica:
  Muscovite block and film, stained and better
  Bookform splittings
Rubber:
  Butyl (GRI)
  Natural, dry
Talc, Indian block, lava grade

Miscellaneous—Group II-E
(In approximate balance)

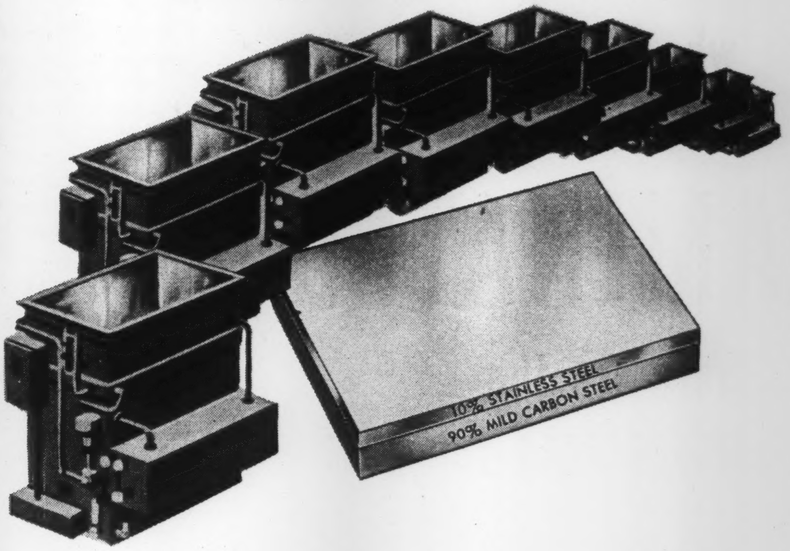
Abrasives, synthetic:
  Silicon carbide
  Aluminum oxide
Graphite, artificial: Electrodes, anodes and special shapes
Mica:
Phlogopite, splittings and block
  Muscovite block and film (lower than stained)
  Muscovite splittings, loose
Paper
Paperboard
Quartz crystals (MBS Grades I and II)
Rubber: Synthetic (G. R. S.)
Talc: Ground, including steatite

Miscellaneous—Group III-E
(In fair to good supply)

Asbestos, Chrysotile: Shorts and waste fibers
Rubber:
  Reclaimed
  Natural, latex

Copies of the complete *List of Basic Materials and Alternates* may be obtained from the nearest district or regional office of the Department of Commerce, or by writing Printing Services, Department of Commerce, Washington 25, D. C.

How to Make Stainless Protection Go NINE TIMES FURTHER... with PERMACLAD
STAINLESS CLAD STEEL



Want stainless protection for your product or equipment—without wasting stainless steel? You'll get it at low cost—with PERMACLAD!

A 10% layer of stainless, inseparably welded to a 90% mild steel backing, gives PERMACLAD the surface characteristics of solid stainless *and* the easy forming qualities of carbon steel. This means real savings in corrosion resistance and in fabrication as well. For you can cold-form PERMACLAD with ease, draw it deeper without intermediate annealing, actually form it into products impossible with many other materials.

Even with the most severe draw, the percentage of cladding (which can be 20% or more if desired) never varies. And the stainless layer remains inseparably welded to its backing. For gleaming, stainless products and corrosion resistant equipment, design and build with PERMACLAD. The coupon below brings you full details in our new 8-page folder (P-98).

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PERMACLAD
STAINLESS CLAD STEEL
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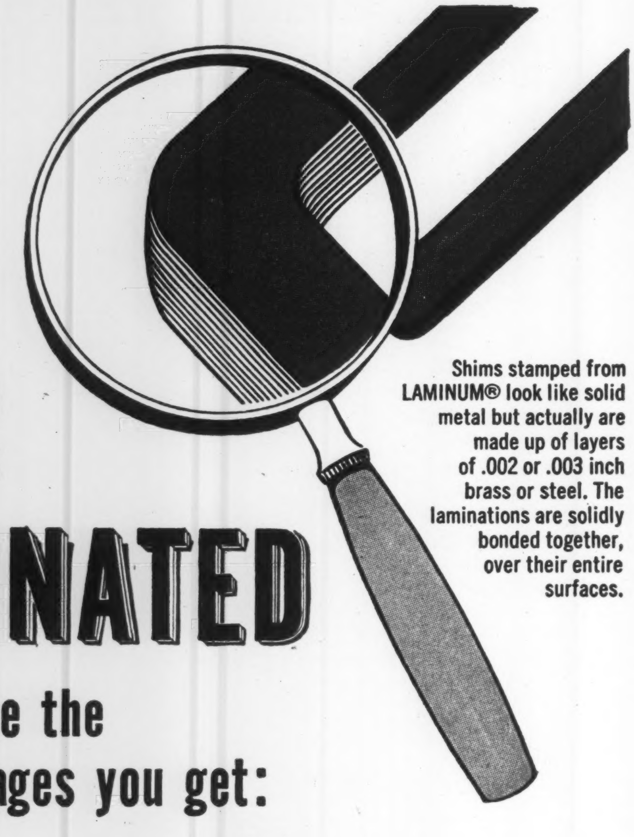

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Design Abstracts

(*Continued from Page* 174)

to introduce errors, especially for long-time measurements of torque. Recognizing that some part of hysteresis must also be creep, the two effects are illustrated in an exaggerated manner by the curves in *Fig.* 1.

To obtain data for the specific problem of evaluating the errors due to hysteresis in a large torque-weighing shaft, test apparatus was designed and constructed, and a series of hysteresis and room-temperature creep tests were conducted on several typical high-strength shafting materials. A pure torque loading was achieved by means of dead weights, the maximum load giving a shearing stress of 24,000 psi in the machined specimen.

It was considered necessary to evaluate hysteresis effects of the order of 0.1 per cent of full-load deflection. This required a sensitivity of approximately 0.01 per cent in the

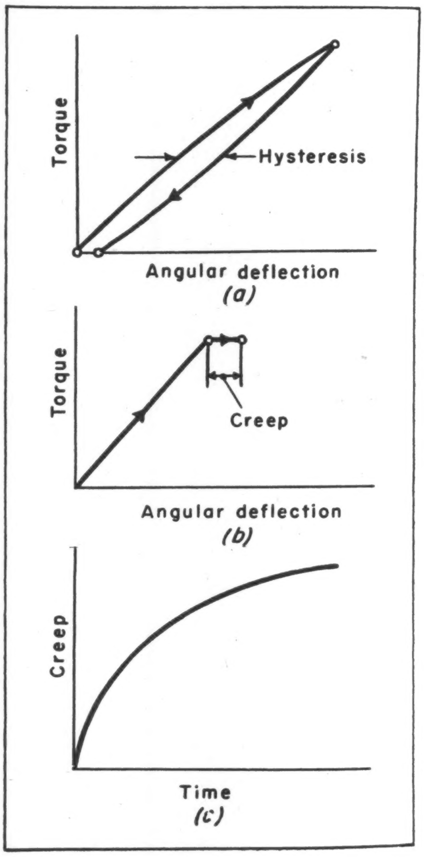
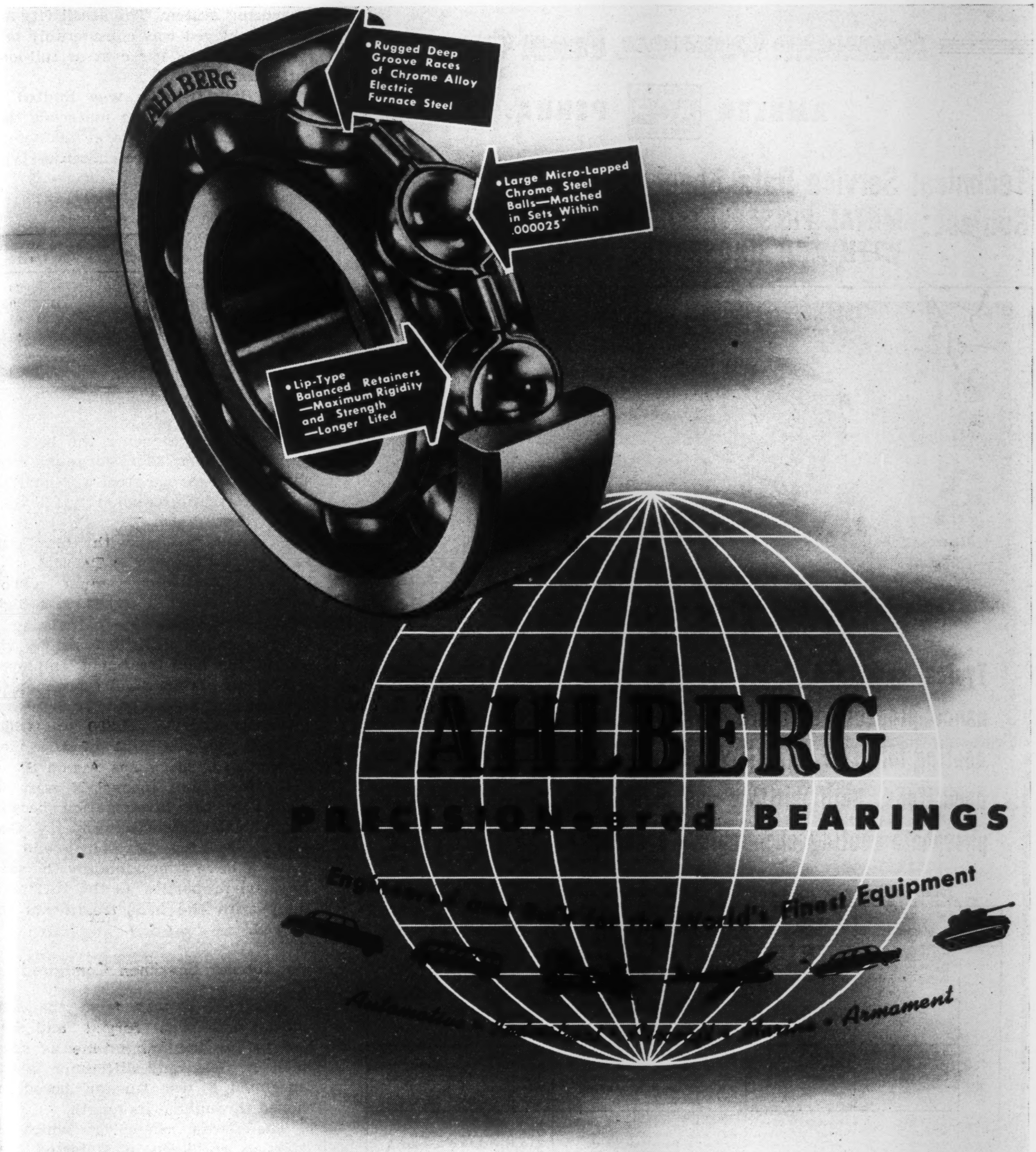


Fig. 1 — Load-deflection diagrams illustrating *(a)*, hysteresis; *(b)*, creep; and *(c)*, typical creep-time relationship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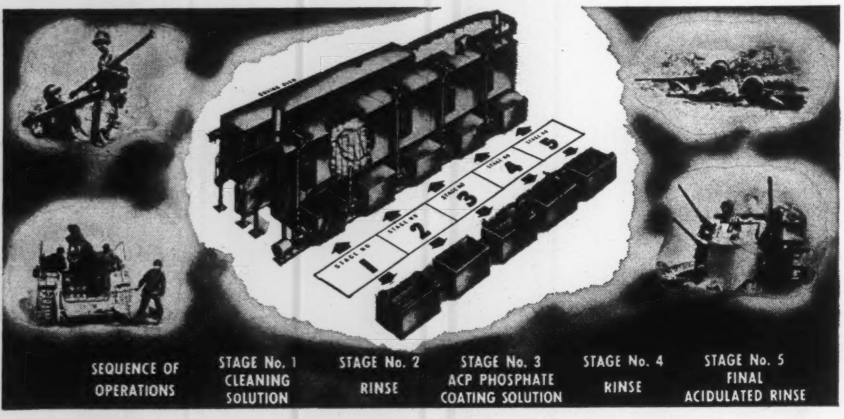
Technical Service Data Sheet
Subject: METAL PRESERVATION AND PAINT PROTECTION WITH ACP PHOSPHATE COATING CHEMICALS


SEQUENCE OF OPERATIONS
STAGE No. 1 CLEANING SOLUTION
STAGE No. 2 RINSE
STAGE No. 3 ACP PHOSPHATE COATING SOLUTION
STAGE No. 4 RINSE
STAGE No. 5 FINAL ACIDULATED RINSE
1
2
3
4
5

U.S. ARMY PHOTOGRAPHS COURTESY OF "ORDNANCE MAGAZINE"

Typical spray and dip phosphating equipment and some ordnance products that are now given a protective phosphate coating for extra durability under all kinds of severe exposure conditions. Both military and civilian applications of ACP phosphate coating chemicals are shown in the chart below.

SELECTION CHART OF ACP PROTECTIVE COATING CHEMICALS FOR STEEL, ZINC, AND ALUMINUM

METAL	ACP CHEMICAL	OBJECT OF COATING	TYPICAL METAL PRODUCTS TREATED	GOVERNMENT SPECIFICATIONS
STEEL	"GRANODINE" Zinc Phosphate Coating Chemical	Improved paint adhesion	Steel, iron, or zinc fabricated units or components, automobile bodies, refrigerators, washing machines, cabinets, etc.; projectiles, rockets, bombs, rifles, small arms, belt links, cartridge tanks, vehicular sheet metal, tank bolts and links, recoilless guns, etc.	MIL-S-5002 JAN-C-490, Grade 1 JAN-F-495 U.S.A. 57-0-2, Type II, Class C U.S.A. 51-70-1, Finish 22.02, Class C U.S.A. 50-60-1 16 E4 (Ships)
	"PERMADINE" Zinc Phosphate Coating Chemical	Rust and corrosion prevention	Nuts, bolts, screws, hardware items, tools, guns, cartridge clips, fire control instruments, metallic belt links, steel aircraft parts, certain steel projectiles and many other components.	MIL-C-16232 U.S.A. 57-0-2, Type II, Class B U.S.A. 51-70-1, Finish 22.02, Class B Navy Aeronautical M-364 U.S.A. 72-53 (See An-F-20)
	"THERMOIL-GRANODINE" Manganese-iron Phosphate Coating	Wear-resistance anti-galling, safe break-in of friction or rubbing parts. Rust proofing.	Friction surfaces such as pistons, piston rings, gears, cylinder liners, camshafts, tappets, crankshafts, rocker arms, etc. Small arms, weapon components. Hardware items, etc.	MIL-C-16232 U.S.A. 57-0-2, Type II, Class A U.S.A. 51-70-1, Finish 22.02 Class A Navy Aeronautical M-364 U.S.A. 72-53 (See AN-F-20)
	"GRANODRAW" Zinc-iron Phosphate Coating	Improved drawing, extrusion, and cold forming	Blanks and shells for cold forming, heavy stampings; tubs; tubing for forming or drawing; wire; rod; etc.	—
ALUMINUM	"ALODINE" Protective Coating	Improved paint adhesion and corrosion resistance	Aluminum products of similar design such as refrigerator parts, wall tile, signs, washing machine tubs, etc; aircraft and aircraft parts; bazookas (rocket launchers), helmets, belt buckles, clothes dryers, clothesline, rocket motors, etc., aluminum strip or sheet stock.	MIL-C-5541 (See also QPL-5541-1) MIL-S-5002 AN-F-20 U.S. Navord O.S. 675 16 E4 (Ships) AN-C-170 (See MIL-C-5541) U.S.A. 72-53 (See AN-F-20)
ZINC	"LITHOFORM" Zinc Phosphate Coating Chemical	Improved paint adhesion	Zinc alloy die castings; zinc or cadmium plated sheet or components; hot dip galvanized stock; galvanneal; signs; siding; roofing; galvanized truck bodies; etc.	QQ-P-416 RR-C-82 JAN-F-495 AN-F-20 U.S.N. Appendix 6 U.S.A. 72-53 (See AN-F-20)

CHEMICALS ACP PROCESSES

WRITE FOR DESCRIPTIVE FOLDERS ON THE ABOVE CHEMICALS AND FOR INFORMATION ON YOUR OWN METAL PROTECTION PROBLEMS

CHEMICALS ACP PROCESSES

measuring system. The sensitivity actually achieved was considerably better, being 0.002 per cent of full-load deflection.

This investigation was limited to high-strength shafting materials that could be supplied in large diameters. Heat treatments were chosen as typical of those producing the best attainable properties in large-diameter shafts. Low-carbon steel was included in the test program merely for comparative purposes.

Table 1—Test Materials

Specimen	Material	Yield Strength (psi)
A	SAE 4140	132,000
B	SAE 4140	132,000
C	SAE 1015	34,800
D	K Monel	120,000
E	Inconel X	153,000
F	SAE 4140	132,000

Materials tested, with their yield strengths, are given in TABLE 1.

The chrome-molybdenum alloy steel, specimens A and B, is a high-strength shafting steel realizing a yield strength of 132,000 psi by virtue of the heat-treatment employed.

The low-carbon steel (specimen C) is fully normalized and possesses a yield strength of 34,800 psi, which is only 26 per cent of the yield strength for specimens A and B.

K Monel and Inconel X were included in the investigation because of their nonmagnetic property. Generally speaking, K Monel and Inconel X have approximately the same physical properties as the SAE 4140 alloy with the heat treatments employed.

Tubular Specimen Compared

Specimen F was from the same billet, and was forged and heat treated at the same time as specimen A. The only difference is that specimen F was tubular, bored and honed throughout its length.

The stress ranges at which the tubular specimen was tested were chosen to be approximately the same as for the solid specimen (specimen A), although exact duplication of stress range was not possible on account of the different section modulus of the two specimens. Thus a reasonably good comparison of the hysteresis of a solid versus tubular specimen was obtained. Data on the latter are of course the more interesting to the investigator of the behavior of materials, because of the almost constant shearing stress in the tubular specimen.

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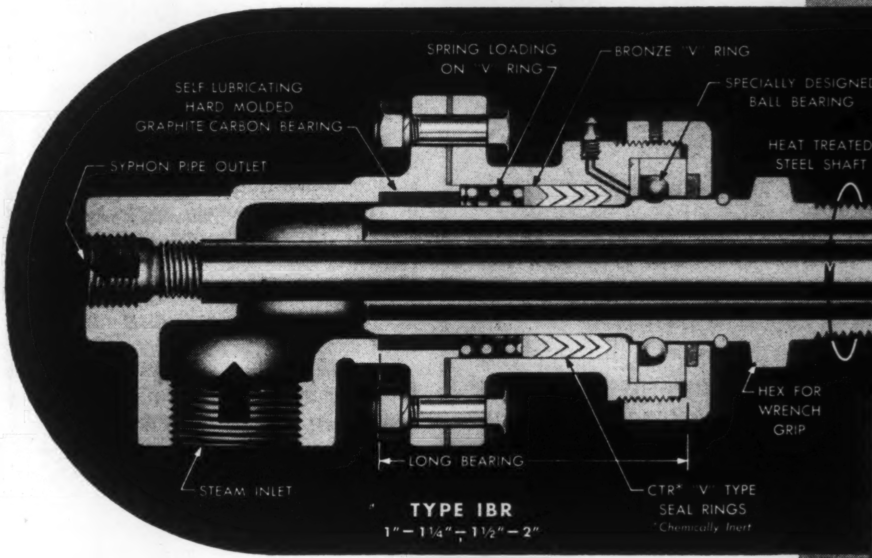
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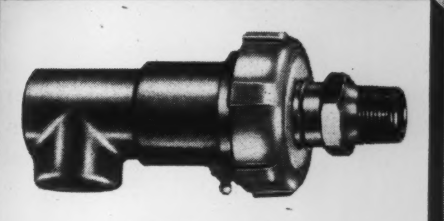

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sis cycle yields only three numbers which relate to the hysteresis. Each of these numbers is merely the difference between the deflection reading of the loading phase and that of the unloading phase of the cycle, for the same load. In the case of reversed loading, five numbers instead of three are thus obtained.

The definition of hysteresis used throughout the paper is as follows:

$$H = \frac{100(\delta_u - \delta_l)}{\delta_{max}}$$

where H = hysteresis in per cent, δ_u is the unloading cycle deflection, δ_l is the loading cycle deflection, and δ_{max} is the maximum deflection obtained in the cycle.

Test Conclusions

A summary of the results of the room temperature creep tests is presented in TABLE 2. The values of creep are approximately the same as the hysteresis values for unidirectional loading.

From the torsional hysteresis and creep tests on the several materials, a number of conclusions may be stated. For stresses up to 24,000 psi in chrome-molybdenum steel (SAE 4140), hysteresis and creep are low in magnitude, 0.03 per cent, for unidirectional loading. For reversed loading, however, the hysteresis is many times greater, being 0.12 per cent for 12,000-psi stress amplitude, and 0.42 per cent for 24,000-psi amplitude. These latter values are sufficiently large to be objectionable in torque measuring systems.

Table 2—Room-Temperature Creep

Specimen	Maximum Stress (psi)	Elapsed Time (hr)	Creep* (per cent)
A	6000	18	0.01
	12000	18	0.02
	18000	17	0.03
	24000	38	0.03
	24000	95	0.03
B	6000	24	0.03
	12000	26	0.01
	18000	23	0.03
	24000	24	0.02
	24000	236	0.04
C	10000	28	0.16
D	18000	75	0.01
E	18000	336	0.01
F	25200	243	0.06

* Based on deflection at maximum stress.

The hysteresis values in torsion for a thin-walled tubular specimen proved to be large compared with the values for a similar solid specimen. The logical explanation is that in the solid specimen the lower stressed material in the core acts as a more perfectly elastic spring (as confirmed by experiments at lower stress levels) in parallel with the spring composed of the highly stressed material in the outer shell of the specimen. This combination quite evidently should be more elastic than a simple tubular specimen. From both the experimental and analytical points of view, a solid cross section for a torque-weighing bar is superior to a tubular cross section. For an SAE 4140 steel tubular specimen, the stabilized hysteresis values were 0.090 per cent and 0.122 per cent for unidirectional loading to stress amplitudes of 21,000 and 25,200 psi, respectively.

Low-carbon steel, as would be expected, displays large hysteresis for all the test conditions imposed, even for the single-direction loading to 6000 psi. The smallest observed values were 0.25 per cent, whereas some cycles showed almost 10 times this amount.

For both steels tested, strain history was an important factor in the results. In all cases, however, the hysteresis apparently had reached a stable value in 3 to 4 cycles of loading. On the first cycle the hysteresis was as much as 5 times the stabilized value obtained after several cycles of loading.

The nonmagnetic alloys, K Monel and Inconel X proved to have exceptionally low hysteresis and creep for shearing stresses up to 24,000 psi. Both hysteresis and creep values were only 0.01 per cent, even for reversed loading.

From Paper No. 51—A-64, "Hysteresis of Shaft Materials in Torsion," presented at the ASME Annual Meeting in Atlantic City, N. J., November 25-30, 1951. Complete copies may be obtained from ASME, 29 W. 39th St., New York 18; $0.25 each to members, $0.50 to nonmembers.

Designing For Human Requirements

By Dr. Ross A. McFarland

School of Public Health
Harvard University
Cambridge, Mass.

ONE of the most important ways of improving safety is to design equipment in terms of human capabilities and limitations. Mechanical design should be intimately related to the biological and psychological characteristics of the workers. It is reasonable to demand that machines be designed from the man

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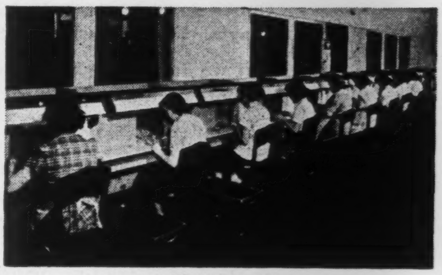
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outward, with the instruments and controls considered as extensions of his nervous system and body appendages. This implies that machines and working areas must be built around the operators rather than placed in a setting without due regard for each individual's requirements and capacities. Unless this is done, it is hardly fair to attribute so many accidents to human failures as is usually the case. If this point of view is carried out in practice, fewer accidents should result, training costs should be reduced, and extensive redesigning of equipment after it is put into use should be eliminated. This principle holds true whether an employee is operating motorized equipment on the highway, flying an airplane, loading express and baggage on a plane, operating a lathe or punch press, or carrying out any of the numerous mechanized duties in a manufacturing or base repair shop.

Room For Improvement

A good illustration may be drawn from the confusion arising when controls for operating the flaps and landing gear of aircraft are too close together or reversed from one plane to another. Inattentive manipulation or mistaken identity resulted in 547 aircraft accidents in one of the services during a 22-month period, January 1943 to November 1944.

Another illustration may be given from the field of automotive windshield design. A new glass has been developed for use in cars to reduce glare. It causes a 27.5 per cent absorption of light as opposed to the 12 per cent level of absorption of ordinary safety glass. This poses a problem for night driving, however, in view of the lowered level of visibility. The glass is designed on the basis of an optical wedge with green tint at top so that it cuts out skylight during day driving and thus probably reduces visual fatigue, but it tends to cancel the color of intersection traffic signals when viewed at close range. A red light looks much darker. Drivers in the older age groups will be especially handicapped, since their light sensitivity is already markedly reduced at low illumination at night. Many states adopted this glass without knowing what its optical quantities were. This suggests that the American Standards Association code on glazing for auto windshields should include some measure of the effect of the glazing on operator visibility. The glass may meet code standards but does not seem to meet human requirements at all times.

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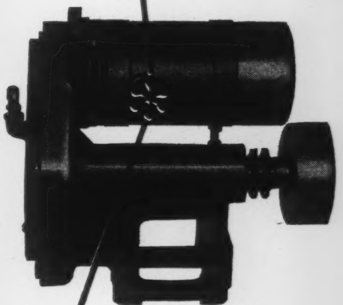

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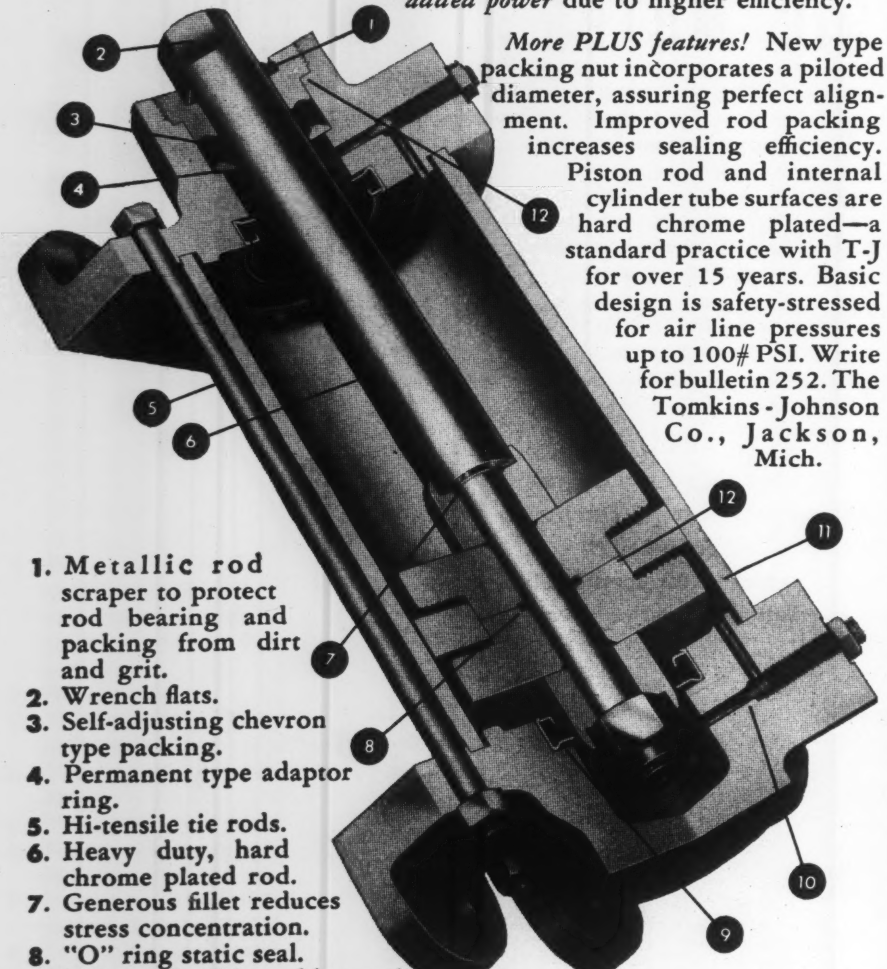

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relatively new and unexplored, partly because accident reports have failed to identify design failure as a cause. Design failures may be so subtle that those responsible for reporting the accidents may not even be aware of them, particularly if they are not trained to recognize such failures.

Analysis Important

All possible faults in equipment and in the working area, as well as the capacities of the operator, should be subjected to an *advance analysis* for preventing accidents. If defects are present, it is only a matter of time before some operator "fails" and has an accident. Advance analysis assumes the following considerations.

The first encompasses an *operational job analysis* that should include a survey of the nature of the task, the work surroundings, the location of controls and instruments, and the way the operator performs his duties. The second implies a *functional concept of accidents*—that is, it anticipates the errors that may occur while the operator is working at the machine. The repetition or recurrence of near or real accidents clearly indicates a need for redesigning. A third consideration relates to *human limitations.* It should be assumed that no operator is a perfect one. In fact, he may be far below the ability adjudged by the designer. If his duties are too complex, the cumulative burden is great and he reaches or exceeds his limits of attention and ability. Finally, a wide *margin of safety* should be provided to eliminate any possible situation that places the operator near his maximum ability with regard to aptitude or effort, especially when adverse factors enter the picture.

Fit Machines To Men

Effective integration of the worker and his equipment is essential in the prevention of accidents. It is often stated that machines do not cause accidents, but that the person who operates and maintains them is the primary source of error. The view presented here is that either the operator or the equipment may be at fault unless the instruments and controls are effectively integrated with the operator. Many errors are inherent in the machine itself, especially if the controls cannot be easily differentiated or if the instruments cannot be read accurately and quickly. In any assemblage or working area, visual links may introduce reading errors if the gages, meters, or dials are illegible. Manual links may also involve errors if the setting or operation of a control or lever is beyond the range of a worker's visual, tactual, or kinesthetic cues. Human limitations must, therefore, be considered in the original design of controls and visual displays if errors by the operator are to be prevented and safety conditions improved.

Provide For Convenience

Controls and Levers: Many errors can be prevented if controls and levers are so designed and placed that rapid and accurate judgment and movements can be made. In the design of controls, particular attention should be given to the shape and color coding of knobs, the radius of knobs and winding handles, the gear ratio, and the amount of friction and inertia.

Some of the more important factors relating to the operation of controls are:

1. Their location for ease and accuracy of reaching
2. Direction of movement for greatest efficiency
3. Speed required in relation to rotary and wrist movements
4. Rate of movement from point to point
5. Rate and accuracy of positioning responses.

Unless controls are carefully designed, properly placed, and easily identified, they are apt to be operated inadvertently.

Another idea meriting study is that concerned with the design and placement of switches and dials. The fundamental principle is to make the various switches of different sizes and shapes in order to eliminate errors in identification.

Visual Display: In regard to visual displays, accidents may ocur if an operator does not clearly perceive the location or movement of the indicators, meters, or dials. A worker must receive clear and unambiguous information concerning his equipment, especially if several tasks must be performed successively or simultaneously for long periods of time.

Design Data Available

The following factors have significant effect on ease of seeing:

1. Size and spacing of critical detail, especially in instrument workings and figures
2. Contrast between object and background
3. Amount of illumination, including the use of color
4. Contrast between the objects to be seen and their surroundings.

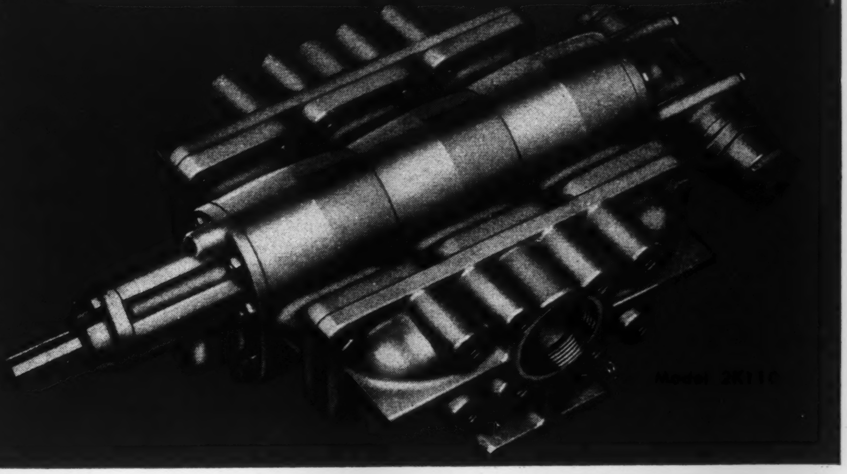
Design criteria for the shape, size, scale markings, and numbering of instruments as well as the most eligible width and length of pointers have been determined experimentally. Although visual displays are more com-

Announcing...

NEW ADDITIONS TO THE DEPENDABLE ROPER LINE

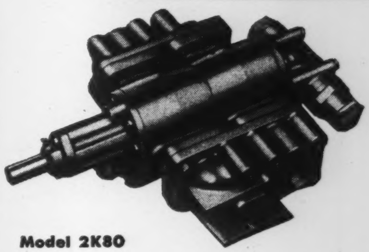
HYDRAULIC

ELEVATOR PUMPS

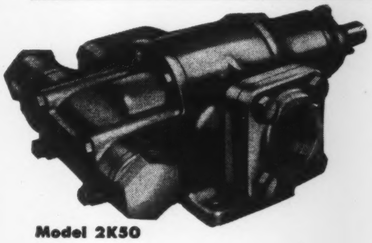


QUIET, QUIET, QUIET!

The newest solution to lift problems . . . dependable Roper pumps that are job-suited to elevators and similar specialized service. Models rated (based on 300 p.s.i.) from 900 r.p.m. giving 25 g.p.m. (minimum) to 110 g.p.m. using 1800 r.p.m. (maximum).



Model 2K80



Model 2K50

Pumps feature: Roper Venturi suction and discharge principle to reduce turbulence, improve efficiency . . . equal size helical gears for uniform flow . . . high lead bronze bearings. Models available with packed box or mechanical seal; with or without relief valve.

SEND COUPON FOR BULLETIN No. 20

ROPER Rotary Pumps

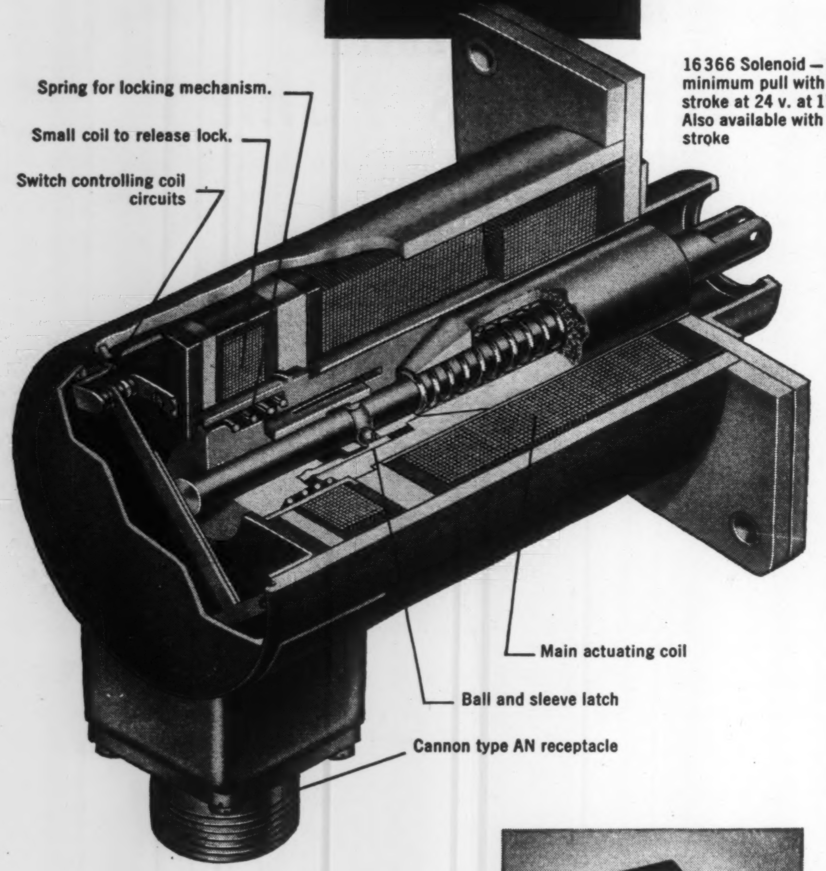
GEO. D. ROPER CORPORATION
242 Blackhawk Park Avenue, Rockford, Illinois

☐ Please send Bulletin No. 20

Name..
Address..
City...
Company..

Here's why those in the ***know***

—demand **CANNON SOLENOIDS**

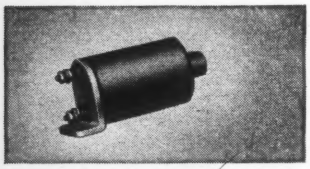

Spring for locking mechanism.
Small coil to release lock.
Switch controlling coil circuits
Main actuating coil
Ball and sleeve latch
Cannon type AN receptacle

16366 Solenoid—18.7 lb. minimum pull with 1/2" stroke at 24 v. at 170°F. Also available with 1-1/6" stroke

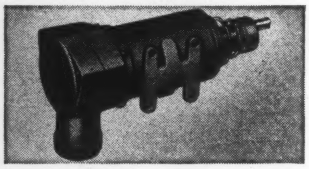
Here's a special purpose Cannon D.C. Solenoid, #16366 for aircraft. Design and safety conditions require that the armature lock in the actuated position for an indefinite time, without relying on a continuous flow of current.

The ingenious ball-and-sleeve latch locks the armature as the main coil circuit is broken through the built-in switch. When current is applied to the smaller coil, motion of the sleeve releases the main armature. Study of the drawing shows how a smooth-acting, positive lock is accomplished.

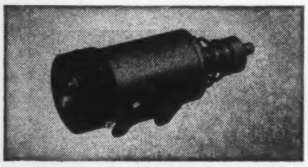
This is one of more than 60 different Cannon D.C. Solenoids built around 18 basic coils for either continuous or intermittent service. Write for Solenoid Bulletin free on request.



#1154 an intermittent service solenoid, 12v, D.C.—10.5 amps.—stroke 9/32", weight 13 oz.



#4440 a continuous service solenoid, 24v, D.C.—3.6 amp. (starting) .42 amp. (holding)—stroke 3/8" weight 16 oz.



11790 a continuous service solenoid, 24v, D.C.—3.6 amp. (starting) .42 amp. (holding)—stroke 3/8" weight 15.5 oz.

CANNON ELECTRIC

Since 1915

CANNON ELECTRIC COMPANY
LOS ANGELES 13, CALIFORNIA

Factories in Los Angeles, Toronto, New Haven. Great Lakes Division, Benton Harbor, Mich. Representatives in principal cities. Address inquiries to Cannon Electric Co., Dept. 185, P. O. Box 75, Lincoln Heights Sta., Los Angeles 31, Calif.

mon, auditory and tactual ones are often used. Auditory signals should be recognizable against the background of the sound pattern, and attempts should be made to use a range where the ear is maximally sensitive with respect to frequency, intensity, and duration.

Arrangement of Equipment: Many errors arise from the assemblage of workers and their equipment. Each man and machine link are potential sources of accidents. This third source of error relates to the arrangement of equipment, resulting in delays of transmission, direct interference, or poor working methods. If the errors are constant, they usually can be eliminated, but if variable, they often indicate the inherent instability of the system or method employed.

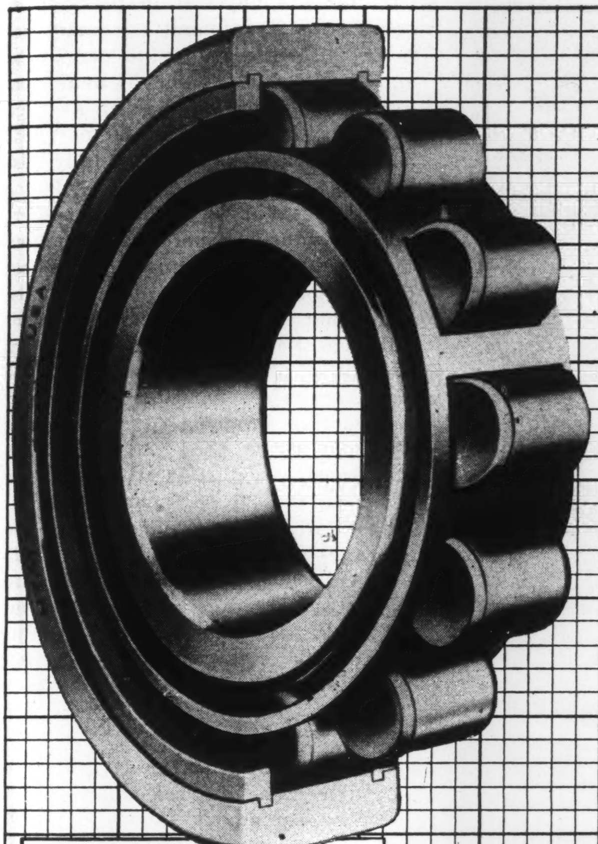
Safety Must Be Planned

A careful job analysis often forms the basis for planning safe designs and practices. Once this analysis is made, equipment should be standardized. Then the worker will be able to react quickly and accurately in moments of stress or uncertainty and to devote his entire attention to critical situations which may arise. Finally, errors can be revealed by an evaluation of the working procedures and arrangement of equipment. This may be done by interviewing operating and supervisory personnel; by observing performance under real or simulated conditions, including the time and frequency of operations, motion picture and sound recordings, and equipment-rating devices, and by experimenting with actual mock-ups. In this way, the interrelationships or links between the equipment and workers can be appraised in arriving at a final evaluation for safe and efficient operating conditions.

Consider Human Limitations

Compilation and use of physical anthropological measurements in relation to the design of equipment offer a fruitful approach to the reduction of accidents. In order to improve the ease, efficiency and safety of equipment, consideration must be given to the application of anthropometric data to design and dynamic body measurements. This last area includes stable posture during operations, an unobstructed view for all operations, the location of controls so that they can be worked at a biomechanical advantage with the precision, speed and force necessary for efficient operation, and adequate restraining or protective devices.

The use of average values to pro-



HYATT
STRAIGHT CYLINDRICAL
ROLLER BEARING

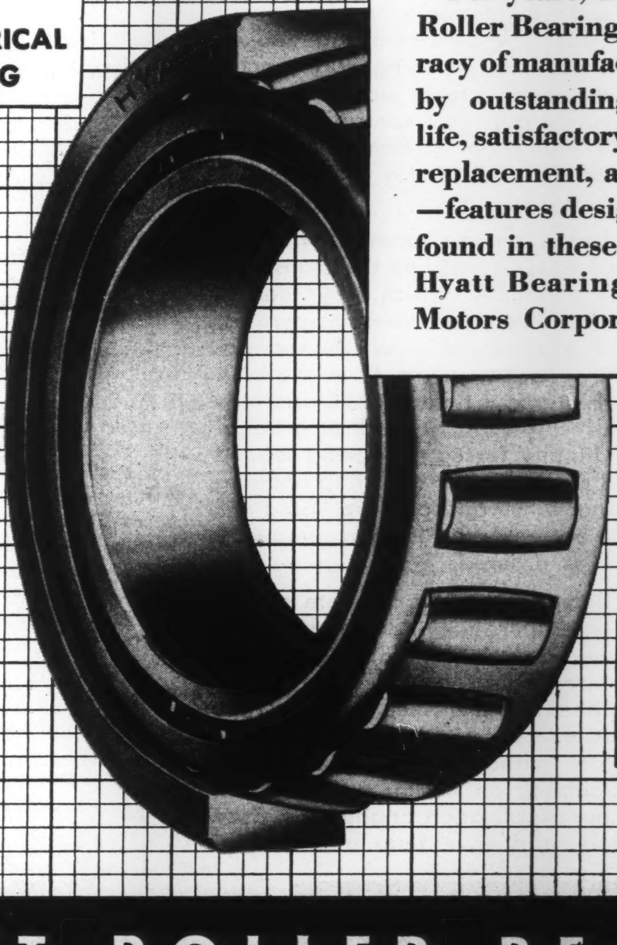
For Flexibility Of Design

When the design calls for greater radial bearing capacity in limited space, Hyatt Hy-Load Roller Bearings can usually provide the solution.

Manufactured in a wide range of sizes, with ten distinct types, and three series of bearing widths, they permit considerable design flexibility.

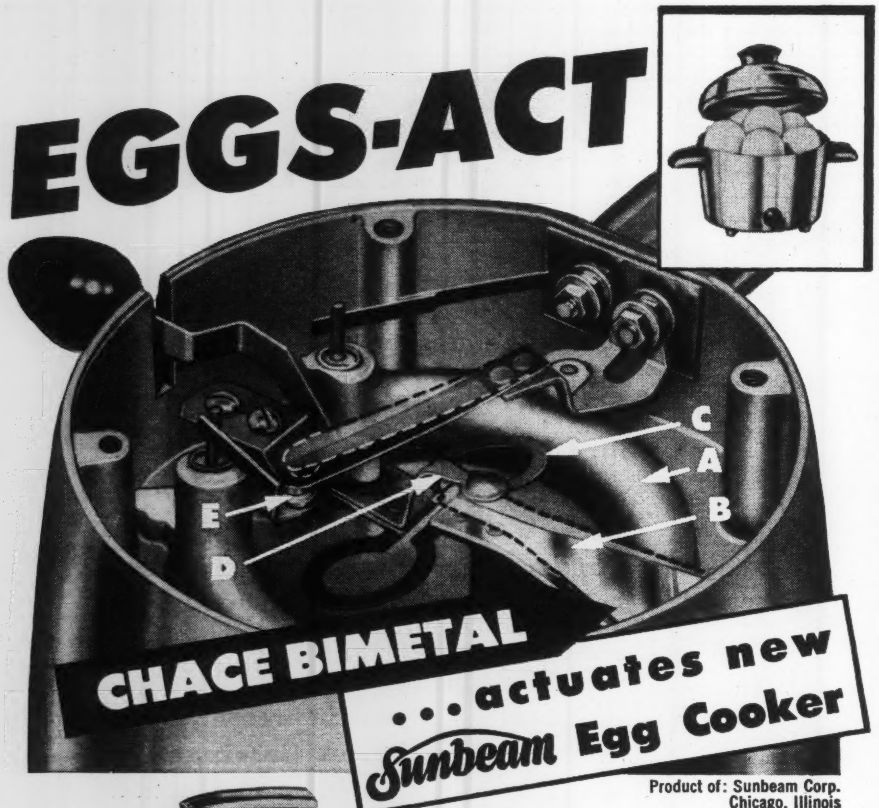
And for positions where both radial and thrust loads are involved or conditions of misalignment present, Hyatt Spherangular Roller Bearings are available in a number of production sizes.

For years, the correctness of Hyatt Roller Bearing design and their accuracy of manufacture have been proven by outstanding performance. Long life, satisfactory operation, infrequent replacement, and freedom from care—features designers look for—will be found in these dependable bearings. Hyatt Bearings Division, General Motors Corporation, Harrison, N. J.

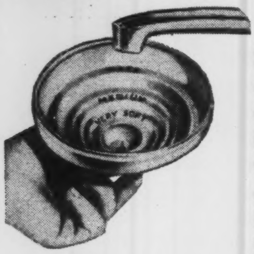


HYATT
SPHERANGULAR
ROLLER BEARING

HYATT ROLLER BEARINGS



Product of: Sunbeam Corp.
Chicago, Illinois



Sunbeam, famous for quality electrical appliances, is a name symbolic of sound design and dependable performance. Example: this new Sunbeam Egg Cooker that turns out your morning egg exactly as you like it—day after day—regulated by Sunbeam's patented control actuated by Chace Thermostatic Bimetal. Minute man or hard-boiled customer, you'll enjoy eggs on the beam with Sunbeam.

The precision timing is based on the amount of water measured in the calibrated lid. Die-cast into the aluminum base is a 500-watt heating core "A" which cooks one to six eggs quickly and evenly. When the water evaporates, the sudden rise in ambient temperature causes the thermostatic bimetal element "B" to deflect away from the high responsive side. The flexibility of the linkage "C" permits considerable deflection of the element and a gradual increase in power which finally forces the spring loaded signal arm "D" past dead center. Result is a snap opening of the circuit breaker contacts "E" and a sharp "ping" as the signal arm strikes the bottom plate (shown removed), announcing the eggs are as ordered.

Your new product may demand equally accurate operation. Whether your aim is temperature indication or control, the right type of thermostatic bimetal is available among the twenty-nine types offered by the W. M. Chace Co. Chace Thermostatic Bimetal is furnished in completely fabricated elements of customers' designs or in strips, coils and random lengths. Write without obligation for your copy of our 64-page handbook on design and selection of bimetal, then call in our Application Engineers before tooling is actually started, and save time and money.

IT BENDS WITH THE HEAT

W. M. CHACE CO.
Thermostatic Bimetal
1616 BEARD AVE., DETROIT 9, MICH.

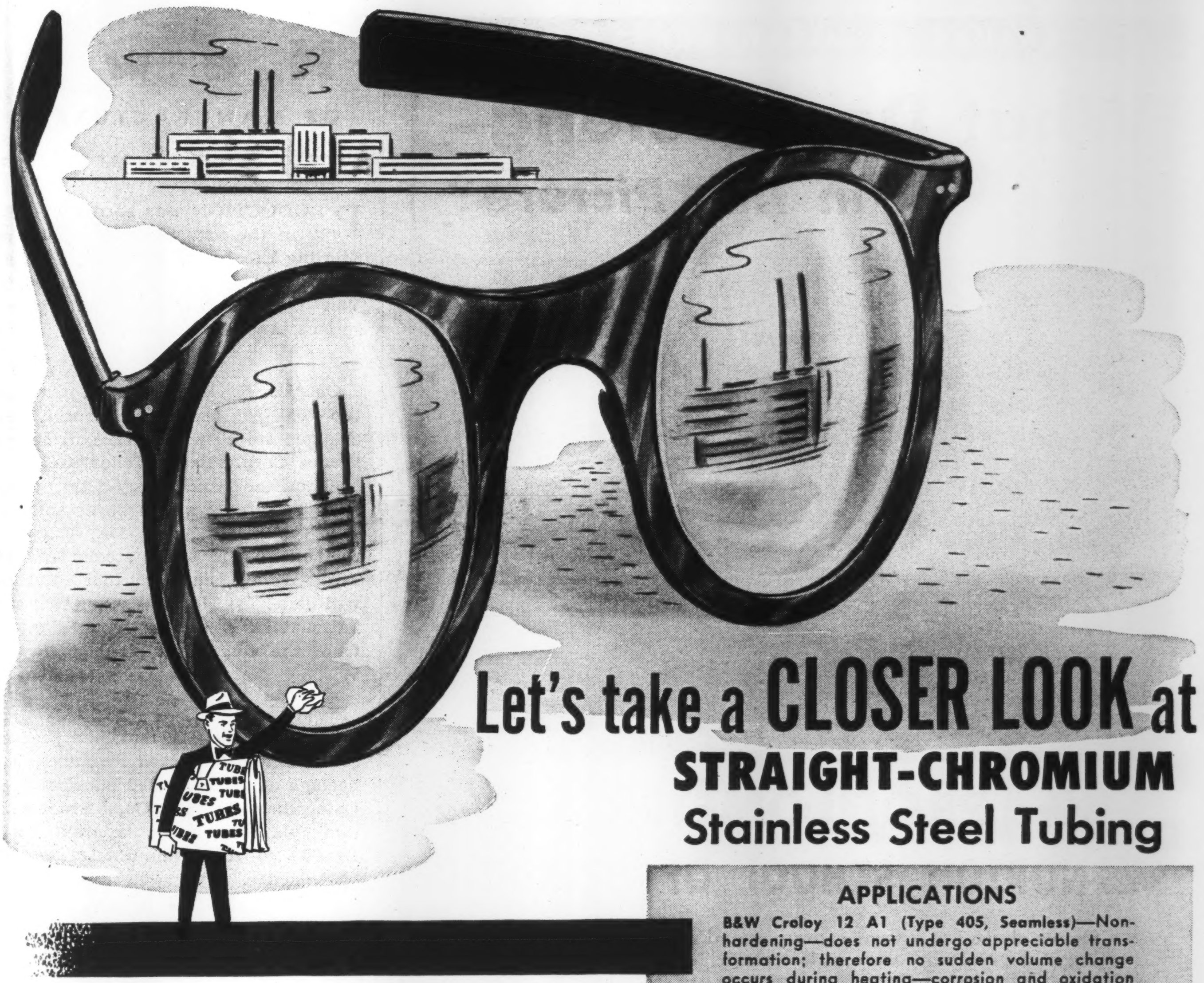
vide for the physical proportions of operators may account for many defects. The average value cannot be employed directly, since, by definition, arrangements based upon an average would be unsuitable for 50 per cent of the operators in a normally distributed group. Provision for 90 or 95 per cent or any other predetermined per cent of potential operators will require identifying the correct cut-off point. Where, for example, arm reach for the operation of manual controls is under consideration, the cut-off point should be well below the average reach; where strength of a structure intended to support one man or where body clearances are concerned, due considerations must be given to the 25 per cent of the operators whose dimensions exceed the average values as well as to the 25 per cent whose measurements are below the average. Operator comments on defects as well as favorable aspects of equipment may further supplement the objective findings.

Design Requires Study

The problem of integrating anthropometric data with the static dimensions of equipment, is one of varying complexity. In some cases, integration is relatively simple, while in other cases, it is extremely complex and difficult. The reason for this is that anthropometric data are standardized under very rigid static conditions. While a man is working, on the other hand, he is in a dynamic situation. As a result, the static data cannot always be applied to the dynamic situation without additional study. Mock-ups can be built to aid in determining the optimum placement and design of the various controls and seats in both static and dynamic situations.

All fields of engineering should consider the human requirements and characteristics of those who are to operate them. This can be done on an experimental basis in collaboration with various teams of scientists in the fields of psychology, anthropology and allied medical areas. The foregoing generalizations imply that no manufacturer should freeze the design of a specific model until it promises to fulfill the human requirements of all concerned and has been submitted to an advance analysis of all possible errors in operation.

From a paper entitled "Human Variables in the Design and Operation of Highway Transport Equipment," presented at the SAE Annual Meeting in Detroit, January 14-18, 1952. *Complete copies may be obtained from SAE,* 29 *W.* 39*th St., New York* 18; $0.25 *each to members,* $0.50 *to nonmembers.*



Let's take a CLOSER LOOK at

STRAIGHT-CHROMIUM

Stainless Steel Tubing

Present restrictions on nickel have cut production of austenitic stainless steel tubing far below demand. If this critical shortage of nickel-bearing stainless tubing is compelling you to find other suitable grades, you should take a closer look at the straight-chromium analyses.

Readily available in quantity from B&W are pipe and tubes of the four non-nickel-bearing types listed at the right with typical uses. These ferritic and martensitic steels are magnetic at ordinary temperatures after all conditions of heat treatment, have relatively high oxidation resistance at elevated temperatures, and resist attack by many corrosive media. With certain modifications in procedures, they can be satisfactorily fabricated by all methods applicable to austenitic grades.

For both pressure and mechanical applications, tubes of straight-chromium stainless analyses are worthy alternates for hard-to-get nickel-bearing stainless types. Would you like a copy of TDC-140 containing technical data on these easy-to-get grades of stainless tubes? Ask Mr. Tubes—your B&W Tube Representative—about their suitability for your applications.

APPLICATIONS

B&W Croloy 12 A1 (Type 405, Seamless)—Non-hardening—does not undergo appreciable transformation; therefore no sudden volume change occurs during heating—corrosion and oxidation resistant. Typical uses: Conveyor lines in oil refining and chemical processing, heat exchanger tubing, boiler tubing in mercury heat cycle, catalytic oil cracking processes where fins have been welded to tubes.

B&W Croloy 12 (Type 410, Seamless and Welded)—Hardenable—moderate corrosion and heat resistance. Typical uses: Machinery in the chemical and food processing and packaging fields.

B&W Croloy 18 (Type 430, Seamless and Welded)—Sufficient ductility for forming simple parts—good corrosion and oxidation resistance—can be polished or buffed to pleasing finish. Typical uses: Conveyor lines in chemical processing field; condensers and piping in production, transportation, and storage of nitric acid and in nitrating operations involving mixed acids; furnace parts; retorts; ornamental structures.

B&W Croloy 27 (Type 446, Seamless)—Corrosion resistant—excellent heat resisting qualities. Typical uses: Furnace parts, heat interchangers, kilns, pyrometer protection tubes, soot blower elements, dehydrogenation equipment in chemical and oil refining fields. Also well suited for glass sealing applications.

THE BABCOCK & WILCOX COMPANY
TUBULAR PRODUCTS DIVISION
General Offices & Plants
Beaver Falls, Pa.—Seamless Tubing; Welded Stainless Steel Tubing
Alliance, Ohio—Welded Carbon Steel Tubing

Sales Offices: Beaver Falls, Pa. • Boston 16, Mass. • Chicago 3, Ill. Cleveland 14, Ohio • Denver 1, Colo. • Detroit 26, Mich. • Houston 2, Texas • Los Angeles 17, Cal. • New York 16, N. Y. • Philadelphia 2, Pa. • St. Louis 1, Mo. • San Francisco 3, Cal. • Syracuse 2, N. Y. Toronto, Ontario • Tulsa 3, Okla.

B&W
SEAMLESS and WELDED
TUBES

TA-1651S

MEASURE IN MICROINCHES RMS

What Does Belong–
in this Picture?

...the PROFILOMETER at the
NORTON SCHOOL OF GRINDING

Shown above is a customer group attending the school of grinding of the Norton Company, Worcester, Massachusetts. Here the latest grinding machine developments are explained to representatives of a number of the country's leading industrial firms.

One piece of equipment appears in this picture... the Profilometer. Obviously, in a discussion of modern grinding techniques, an accurate knowledge of the surface finishes that are secured is of primary importance. Norton Company recognizes the Profilometer as the instrument which does provide dependable roughness ratings in microinches RMS—the accepted standard of measurement throughout industry. For that reason, the Profilometer *does* belong in this picture—and on this conference table.

To the men who attend these sessions, the value of the Profilometer increases immeasurably when they put it to everyday use in the production departments of their own plants. There it becomes a part of routine grinding and other machining procedure . . . a means to secure exactly, quickly and easily the information desired on surface finishes. That is why you find it "in the picture" in their companies and wherever quality control is a consideration.

PROFILOMETER

To learn how the Profilometer can help cut costs in your production, write today for these free bulletins.

Profilometer is a registered trade name.

PRCo
PHYSICISTS RESEARCH COMPANY
Instrument Manufacturers
ANN ARBOR 13 • MICHIGAN

News
OF MANUFACTURERS

PRODUCTION was started recently in the new $2,000,000 plant of **Sterling Electric Motors Inc.,** Los Angeles. The new factory, located in Van Wert, O., will produce gears, splines, and gear boxes.

◆

Charles H. Besly & Co., Chicago tap and grinder manufacturer, has changed its corporate title to **Besly-Welles Corp.** Besly-Welles executive headquarters and Besly-Titan abrasives sales offices will be established at 20 North Wacker Dr., Chicago; the office and local stocks of the Besly-Welles cutting tool division will be at 184 North Wacker Dr.; and national sales will be handled direct from the company's plant at Beloit, Wis.

◆

Trackson Co., Milwaukee, a producer of tractor-mounted machines, has become a wholly-owned subsidiary of **Caterpillar Tractor Co.** Trackson's two plants occupy approximately 150,000 sq ft of manufacturing and office space.

◆

General offices of **Mallory-Sharon Titanium Corp.** have been moved from Indianapolis to Niles, O. This is a jointly owned company formed by **P. R. Mallory & Co. Inc.,** Indianapolis, and **Sharon Steel Co.,** Sharon, Pa., for the melting and fabrication of titanium and its alloys. The melting furnace located in Indianapolis is being moved to Niles, and three new furnaces to be installed there will bring available titanium melting capacity at Mallory-Sharon to two million pounds in 1952. Also, the laboratory, engineering, and research work on titanium now being carried out in Indianapolis will be established in Niles.

◆

The purchase of a new factory building, located at 1521 East Grand Ave., El Segundo, Calif., has been announced by **International Rectifier Corp.** The present plant will be maintained for research and development work.

◆

A tract of more than 400 acres for industrial development has been procured by **Hotpoint Inc.** at 95th St. and Harlem Ave., approximately 20

PLANT REPORT

16,320 holes tapped per 8-hour shift with one machine . . . every one lubricated with Norgren Oil Fog. 51 taps per chucking.

INSTALLATION:

New type tapping machine built by the Snyder Tool and Engineering Co., Detroit, for use by one of the "big 3" automobile manufacturers. The machine taps 51 holes in an engine block at one chucking; taps 40 blocks an hour; replaces 4 machines in the production line.

PROBLEM:

To obtain uniform lubrication and cooling of all 51 taps and eliminate the use of a messy coolant system.

SOLUTION:

Use of a Norgren Oil Fog Lubrication System consisting of air filters, air pressure regulators, Oil-Fog Lubricators and aerosol distributors. Solenoid valves control intervals of oil-fog distribution to the taps.

RESULTS:

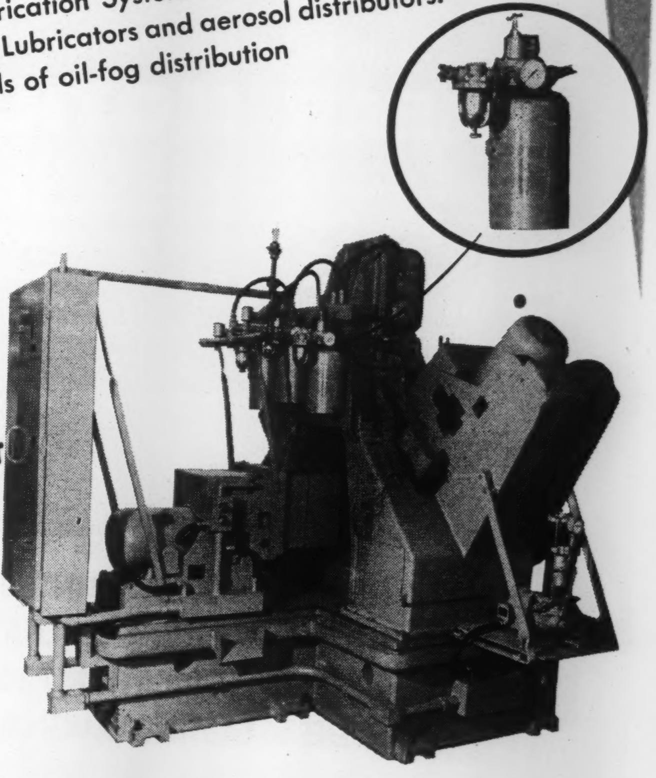
BETTER TAP HOLES...

. . . oiled air lubricates, cleans, cools all 51 taps.

LESS TAP BREAKAGE

LONGER TAP LIFE

NO MESSY COOLANT SYSTEM



Norgren BLUEPRINTS

- **LUBRICATORS**
- **FILTERS**
- **REGULATORS**
- **VALVES**
- **HOSE ASSEMBLIES**

Norgren

25 YEARS OF HELPING TO MAKE AIR POWER SERVE INDUSTRY BETTER

C. A. NORGREN CO.

3442 So. Elati—Englewood, Colorado (Suburb of Denver)

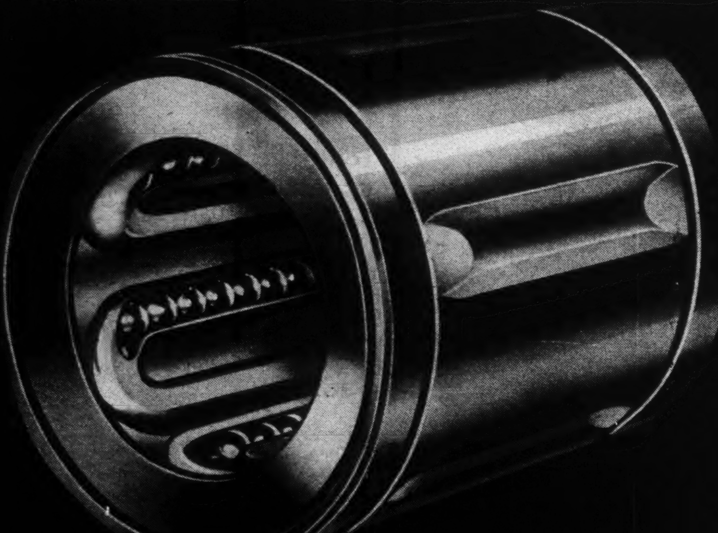
Gentlemen: Please send me your free Norgren Blueprint No. 114, giving complete data on above lubrication system.

NAME____________________________

ADDRESS____________________________

COMPANY____________________________

BALL BUSHING



The BALL BEARING for your

LINEAR MOTIONS

Sliding linear motions are nearly always troublesome. Thousands of progressive engineers have solved this problem by application of the Precision Series A or Low-Cost Series B BALL BUSHINGS.

Alert designers can now make tremendous improvements in their products by using BALL BUSHINGS on guide rods, reciprocating shafts, push-pull actions, or for support of any mechanism that is moved or shifted in a straight line.

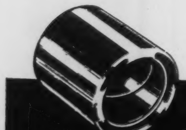
Improve your product. Up-date your design and performance with BALL BUSHINGS!

Now manufactured for ¼″, ½″, ¾″, 1″, 1½″ and 2½″ shaft diameters.

LOW FRICTION • LOW MAINTENANCE
ELIMINATES BINDING AND CHATTER
SOLVES SLIDING LUBRICATION PROBLEMS
LONG LIFE • LASTING ALIGNMENT

Progressive Manufacturers Use Ball Bushings
—A Major Improvement at a Minor Cost

THOMSON INDUSTRIES, Inc.
Dept. E MANHASSET, NEW YORK



Write for descriptive literature and the name of our representative in your city.

Also manufacturers of NYLINED Bearings — DuPont NYLON within a metal sleeve—for rotation and reciprocation.

miles from the Chicago Loop. Acquisition of this land represents the final step in a five-year expansion program announced in 1947 and will provide a site for the erection of a one million sq ft manufacturing facility when defense restrictions permit. The new manufacturing space will be used at first for defense work and, according to present plans, will ultimately provide expanded refrigeration-products facilities.

◆

A plant is being built for **Pastushin Aviation Corp.**, Los Angeles, at Hawthorne, Calif. It will be used for production of aircraft components under subcontract.

◆

Thomas Associates, Los Angeles, has established a branch manufacturing plant at Coffeyville, Kans., to produce and stock all volume TA clips, clamps and related items for aircraft and industrial customers in the Midwest area.

◆

Construction of a new wing to house two new research laboratories has been completed by **Eutectic Welding Alloys Corp.,** Flushing, N. Y. The staff of the new laboratories will concentrate on the development of new welding alloys utilizing fewer critical metals. Research on new metals, such as titanium, is also included among the projects scheduled for study by the group.

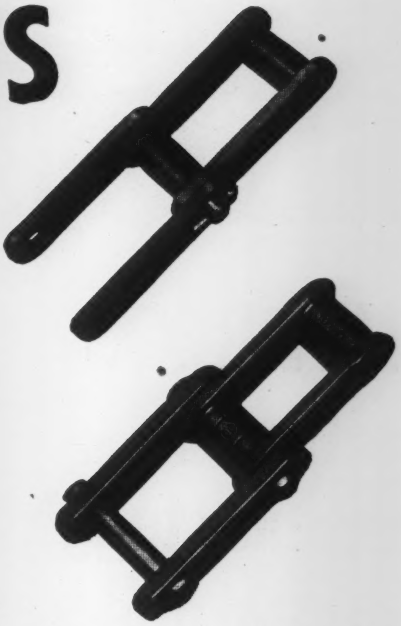
◆

The firm name of the Penn Electric Switch Co., Goshen, Ind., has been changed to **Penn Controls Inc.** This action was taken in order to describe more accurately the character of the company's business, which is manufacturing automatic controls for heating, refrigeration, air conditioning, gas appliances, engines, and pumps and air compressors.

◆

The Convair Guided Missile Division of **Consolidated Vultee Aircraft Corp.,** San Diego, Calif., has leased 79,000 sq ft of building space at the Los Angeles County fairgrounds to provide interim facilities for engineering, experimental shop and laboratory activities in Pomona. By August 1, the buildings to house the Navy-Convair guided missile plant will be completed on the western edge of Pomona. Convair also has announced the establishment of the Ordnance Aerophysics Laboratory at Daingerfield, Tex., as a separate division of the company. Facilities of this division include a supersonic wind tunnel, a ramjet-engine test burner and a high-altitude test chamber for testing large-scale ramjet en-

[illegible]S and [illegible]CKETS



General purpose Chains for use on high-production units in the Industrial and Construction fields . . . shovels, rollers, conveyors, bucket elevators, drilling rigs, and for drives.

Jeffrey Chains and sprockets will keep your equipment operating at its best. They have a long and consistent record for lowering material handling costs . . . have quite a reputation for thrifty performance and enduring reliability.

Demand high-quality Chains and Sprockets . . . the kind that Jeffrey builds.

Send for catalog No. A418.

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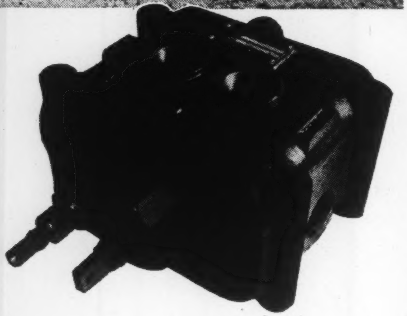
ESTABLISHED 1877

Complete Line of Material Handling, Processing and Mining Equipment



HYDRECO solves another tough control problem

HYDRECO VW SERIES
HYDRAULIC STEERING VALVE

The Terra-Cobra, built by Wooldridge Manufacturing Company, Sunnyvale, California, hauls a lot of dirt and travels fast. The HYDRECO designed and built model VW2X1 steering control valve provides the effortless hydraulic steering and perfect control that this big machine requires for most efficient operation.

Slack in the steering chains and possible momentary loss of control cannot develop, as flow controls built into the valve keep positive tension on the steering chains under all conditions.

As the flow controls are built right into the same valve housing with the steering controls, external piping is reduced to a bare minimum.

Let HYDRECO engineers show you how fast and safe control of earth moving equipment and other mobile units means savings for users and profits for you. Please write us.

HYDRECO OIL HYDRAULIC CONTROLS

HYDRAULIC EQUIPMENT COMPANY
1106 EAST 222nd STREET • CLEVELAND 17, OHIO

gines at simulated altitudes of approximately 20 miles and at four times the speed of sound.

◆

A new continuous galvanizing plant will be constructed at Martins Ferry, O., by **Wheeling Steel Corp.,** Wheeling, W. Va. The plant will be used for the production of galvanized sheets in coils 3000 to 4000 ft long.

◆

On the occasion of its fiftieth anniversary, the firm name of Chicago Metal Hose Corp., Maywood, Ill., was changed to **Flexonics Corp.**

◆

Plans for a new and larger manufacturing plant, located at 3601 Howard St., Skokie, Ill., have been announced by **Ohmite Mfg. Co.,** Chicago, manufacturer of electrical control equipment. The new plant will provide enlarged facilities for the company's increased defense production.

◆

The **Bassick Co.,** Bridgeport, Conn., a subsidiary of **Stewart - Warner Corp.,** has leased manufacturing space in New Haven, Conn., to provide for increased production of its heavy-duty industrial caster line. Screw machine, welding, grinding, finishing and assembly operations will be conducted in the new plant, which is located in New Haven Terminal property.

◆

A new 26,000-sq ft factory expansion has been completed at Cheboygan, Mich., by **Detroit Tap and Tool Co.,** Detroit. The new plant was constructed in order to increase production of taps, thread gages, thread milling cutters, and other threading tools.

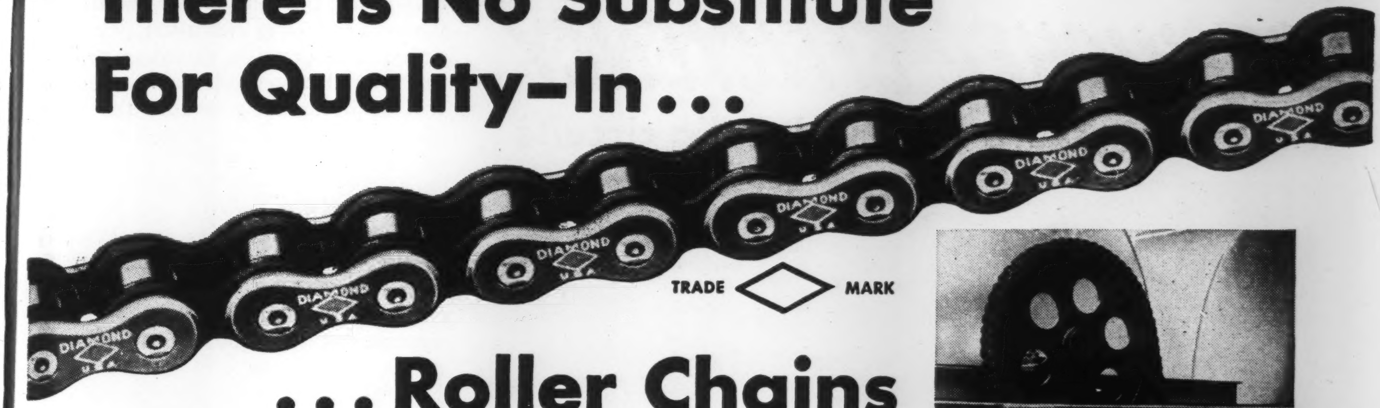
◆

The Nelco Tool Co., Manchester, Conn., producer of carbide-tipped metal cutting tools, recently completed a building program which more than doubles its manufacturing space.

◆

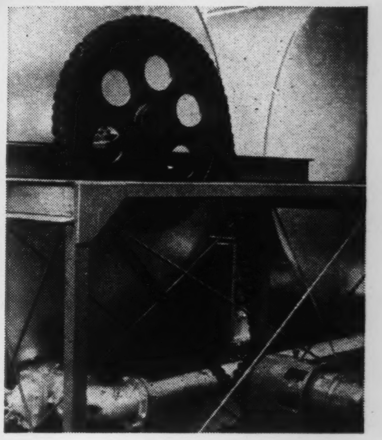
Continuing a program of expansion in aluminum fabrication, **Revere Copper and Brass Inc.,** New York, will extend aluminum operations to the Pacific coast by approximately doubling the size of its present Los Angeels plant, which currently is fabricating only copper and copper alloys. Plans call for the opening of a 50,000-sq ft addition in the spring of 1953. The plant will produce aluminum tube and extruded shapes in a variety of alloys, both heat treated and non-heat treated. Also an-

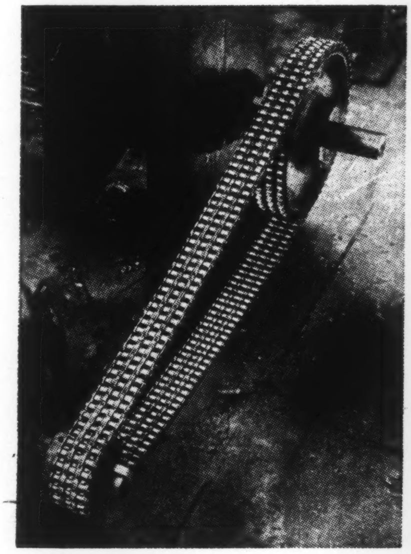
There Is No Substitute For Quality–In...



TRADE ◇ MARK

...Roller Chains





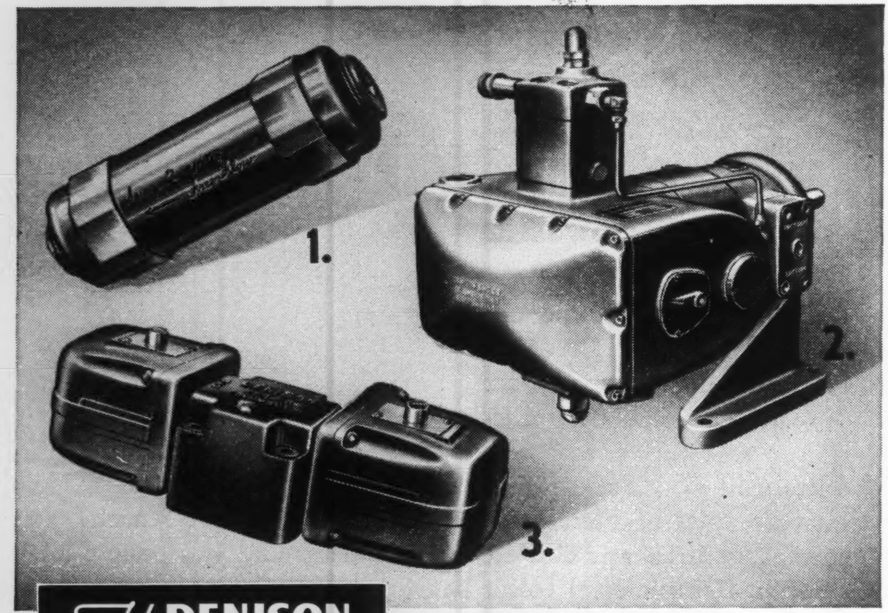
● Back of every link, every foot of Diamond Roller Chain are more than 60 years of experience in the production of this one type of product. Add to this the cumulative results of metallurgical and engineering research, special facilities and skilled craftsmanship and you have a smooth, flexible steel roller bearing type power transmission of uniform quality . . . quality, for which there is no substitute.

DIAMOND CHAIN COMPANY, Inc.
Dept. 435, 402 Kentucky Avenue, Indianapolis 7, Indiana
Offices and Distributors in All Principal Cities

DIAMOND ROLLER CHAINS

FOR HIGHER EFFICIENCY

in high-pressure oil-hydraulic circuits



DENISON HydrOILics

Pumps and Controls

Meet Circuit Needs to 5000 psi

1. DENISON'S SURGE-DAMPING CONTROL *eliminates shock without affecting other circuit functions!* About the size of a garden-hoze nozzle, it is easily installed in any circuit. Adjusts automatically to any working pressure . . . acts with split-second speed . . . can't retard cycling speed.

2. One of the many Denison high-pressure high-volume pumps for either constant or variable volume delivery. Volume control by stem, handwheel, or pressure compensation. Capacities: 2 to 35 gpm. Simplified axial-piston design — rugged, dependable, highly compact.

3. Spool sticking is eliminated in long-cycling, high-pressure operations by Denison's pilot operated 4-way Solenoid Valves. Using system pressures to move the spool through either internal or external pilot action, they assure smooth, quick positive action under all conditions. $\frac{3}{4}''$ and $1\frac{1}{2}''$ sizes.
Denison has the answers to today's increasing needs for complete packaged power units built for long life and extra efficiency in high pressure oil-hydraulic systems of almost every type. Write for information on HydrOILic Pumps, Valves, Controls, Pumping Units, Fluid Motors and other components or for recommendations on your specific needs!

The DENISON Engineering Co., 1156 Dublin Rd., Columbus 16, Ohio

DENISON
Pumps and Controls

nounced by Revere is an expansion in aluminum operations at Baltimore, where a 3000-ton extrusion press and added tube-drawing facilities are being installed. These new facilities will approximately double the plant capacity for drawn aluminum tube and extruded shapes.

◆

Production facilities of **Whitney Chain Co.,** Hartford, Conn., are being increased by the construction of a one-story plant addition containing approximately 10,000 sq ft of floor space. This area will be devoted to the manufacture of fabricated steel sprockets and large pitch roller and conveyor chains. New press capacity will be installed, including heavy presses ranging from 280 to 400 tons.

◆

Pittsburgh Plate Glass Co., Pittsburgh, recently announced plans to purchase a 147,000-sq ft factory at Shelbyville, Ind., as a manufacturing facility for its new Fiber Glass division. Production is expected to begin early in the fall on strand fiber and superfine fiber.

◆

Greer Hydraulics Inc., Brooklyn, N. Y., manufacturer of aviation test equipment and devices for industrial hydraulic systems, has recently completed a new addition to its plant at 454 Eighteenth St. This expansion and the leasing of additional space in another building at 255 Eighteenth St. has increased the office and plant space to more than 140,000 sq ft.

◆

Dudco Products Co., Hazel Park, Mich., manufacturer of vane-type hydraulic pumps and motors, has been sold to **The New York Air Brake Co.** of New York and will now be operated as the Dudco division of the parent company. No changes in personnel or operation have been made.

◆

A $450,000 building program which will add more than 80 per cent to the permanent building area of **Luscombe Airplane Corp.,** Dallas, Tex., was announced recently. It is expected that this expansion will be completed by July 1.

◆

Production facilities of **The American Welding & Mfg. Co.,** Warren, O., have been expanded by the acquisition of The Warren Machine & Die Co., which has become the Warren Machine & Die Division of American Welding. Another addition to the company's plant and equipment is under way immediately adjacent to the main plant. Part of these facilities, which will provide for increased production of jet and reciprocating engine parts, is expected to be ready for use early in March.

◆

An expansion program which will increase the production capacity of the **General Electric Co.** silicone plant in Waterford, N. Y., has been announced. Additional manufacturing facilities are being installed and are expected to be operating by the end of the year. The company has formed a new chemical division product department to be known as the silicone products department, with Dr. Charles E. Reed as general manager.

◆

Farrel-Birmingham Co. Inc., Ansonia, Conn., has purchased the common stock of **Consolidated Machine Tool Corp.,** Rochester, N. Y. Production of the Consolidated line of machine tools will continue at the Rochester plant, which will be operated as a subsidiary of Farrel-Birmingham.

◆

Construction of a major unit for the production of polyethylene resins has been announced as an addition to the Texas City plant of **Carbide and Carbon Chemicals Co.,** a division of **Union Carbide and Carbon Corp.,** New York. The unit is expected to be in operation early in 1953, and annual production is estimated at 50 million pounds.

◆

The formation of a new company to engineer, manufacture and sell high-speed automatic stamping presses was announced recently. To be known as **Precision Flexopress Corp.,** the new company will be located at 910 Baymiller St., Cincinnati, O.

◆

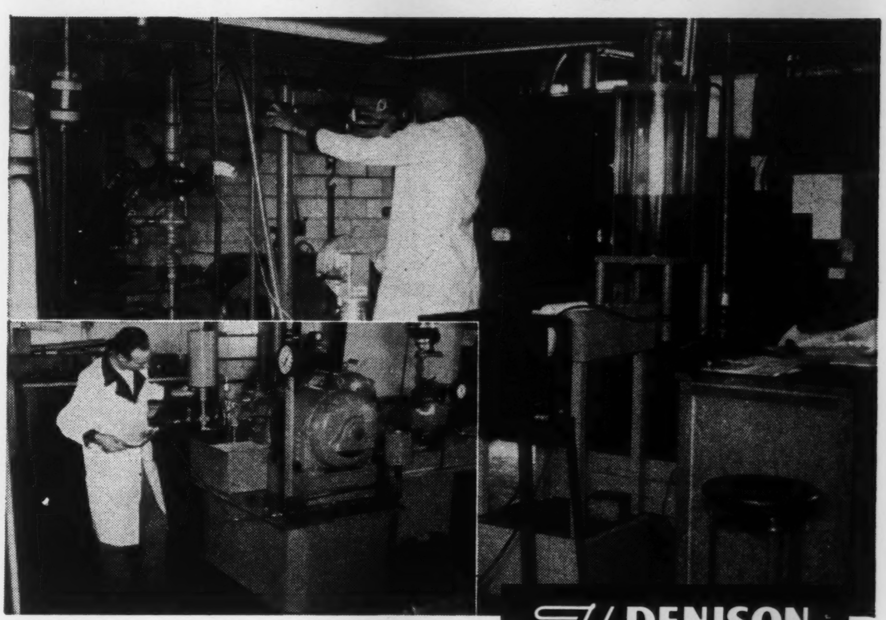
The Communications and Electronics division of **Motorola Inc.,** Chicago, has been moved to new quarters at 4501 W. Augusta Blvd. The new building, which is adjacent to the division's former location, provides 200,000 sq ft of plant and office space.

◆

Physicists Research Co., Ann Arbor, Mich., manufacturer of the Profilometer and other shop instruments for surface measurement and control, has changed its name to **Micrometrical Mfg. Co.** Concurrently, the company's development operations have been moved to a new building and are now operated as Micrometrical Development Corp. at 2821 S. State St. in Ann Arbor.

HYDROILIC RESEARCH DOES IT

with constant advancement in designs and methods



DENISON HydrOILics

Pumps and Controls

Shown on Opposite Page are Typical Examples

Applying the full advantages of oil-hydraulic equipment to new requirements that play a major part in today's fast-moving industrial progress, has been the work of a continuous research and development program at Denison for many years.

As a result, press equipment has been reduced in bulk and complexity . . . its speed and efficiency have been increased for all types of production jobs . . . and newly developed all-automatic control features slash costs even on short run production jobs. Pumps of improved design, with full emphasis on efficiency at high pressures, are now a reality. Greater accuracy has been incorporated into pressure controls for all types of circuit needs up to 5000 psi. Tooling designs and methods that reduce scrap losses, boost production rates and improve the quality of work are now in wide, daily use because of procedures developed at Denison.

Recently, special research in applying high-pressure hydraulics to new and bigger commercial and defense-production needs has brought remarkable gains in many phases of industry.

This continuing research program has made Denison a preferred source for new, improved equipment, better methods, and advanced ideas — like the valves that *eliminate* hydraulic shock and spool-sticking, described on the opposite page. You can count on Denison for *better* hydraulic equipment.

WATCH FOR NEW PRODUCTS TO BE ANNOUNCED SOON!

The DENISON Engineering Co., 1156 Dublin Rd., Columbus 16, Ohio

DENISON
Oil-Hydraulic Equipment

No Swing—
No Sway—
No Jerk...
TWIN DISC
CLUTCHES AND HYDRAULIC DRIVES

The load moves easier for any electric motor with a Twin Disc Hydraulic Coupling or HYDRO-SHEAVE Drive. That's because, when starting the load from a dead stop, the "slip" of the hydraulic fluid permits the motor to accelerate fast from low rpm to working torque.

This smooth, cushioned acceleration eliminates jerking, eliminates swinging, eliminates swaying.

The pay-off comes in more work done, in less maintenance, in lower electric bills by leveling current surges.

Ask Calabar, Philadelphia Tramrail, Robbins & Myers, Whiting, or any other leading hoist manufacturer to show you their models equipped with Twin Disc Hydraulic Couplings. Or see your nearest Twin Disc Hydraulic Dealer.

TWIN DISC CLUTCH COMPANY, Racine, Wisconsin · HYDRAULIC DIVISION, Rockford, Illinois

BRANCHES: CLEVELAND · DALLAS · DETROIT · LOS ANGELES · NEWARK · NEW ORLEANS · SEATTLE · TULSA

Society ACTIVITIES

COMPLETION of the board of directors to head the **Centennial of Engineering** has been announced by its president, Lenox R. Lohr. The celebration, which will be held in Chicago this year, marks the 100th anniversary of the establishment of engineering as a recognized civilian profession in this country. Other officers of the Centennial are: Carlton S. Proctor, vice president; Titus G. Le Clair, treasurer; and Charles F. Kettering, executive committee chairman. Frank W. Edwards is general manager of the Centennial and E. L. Chandler is secretary of the convocation committee.

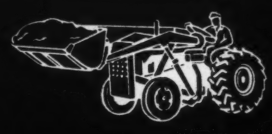
◆

Dr. Daniel P. Barnard IV, research co-ordinator of Standard Oil Co. (Indiana), has been elected president of the **Society of Automotive Engineers** for 1952. Newly elected vice presidents are: A. W. Dallas, Air Transport Assn. of America; D. Roy Shoults, General Electric Co.; F. C. Mock, Bendix Aviation Corp.; V. M. Exner, Chrysler Corp.; W. G. Ainsley, Sinclair Research Laboratories, Inc.; V. A. Crosby, Climax Molybdenum Co.; J. G. Moxey, Jr., Sun Oil Co.; H. E. Churchill, Studebaker Corp.; E. F. Gibian, Thompson Products, Inc.; C. A. Hubert, International Harvester Co.; Linn Edsall, Philadelphia Electric Co.; and F. W. Kateley, ACF-Brill Motors Co. Re-elected treasurer was B. B. Bachman of the Autocar Co. Newly installed members of the SAE Council are: E. F. Armstrong, General Motors of Canada, Ltd.; W. E. Beall, Boeing Airplane Co.; R. F. Lybeck, Esso Standard Oil Co.; Robert Cass, White Motor Co.; R. W. Goodale, Standard Oil Co. of Calif.; and Herb Rawdon, Beech Aircraft Corp.

The *Horning Memorial Award* was presented to D. L. Pastell of E. I. du Pont de Nemours & Co. on the basis of the excellence of his technical paper "Precombustion Reactions in a Motored Engine." This award is presented annually by the SAE for outstanding contributions to man's knowledge of the science of matching fuels and engines.

◆

The **American Standards Association** recently honored the National Bureau of Standards on the occasion



On Mobile Equipment

VICKERS
BALANCED VANE PUMPS
Do a Better Job and Last Longer...
AT LOWER OVERALL COST

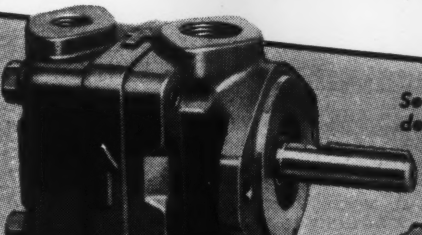
These Vickers Balanced Vane Type Pumps are especially designed and built for the severe service encountered with mobile equipment.

Their design automatically compensates for wear throughout pump life. Correct clearances are maintained continuously so that efficiency and delivery rate remain high. As a result, it is not necessary to select a larger pump to allow for loss of delivery under normal service conditions.

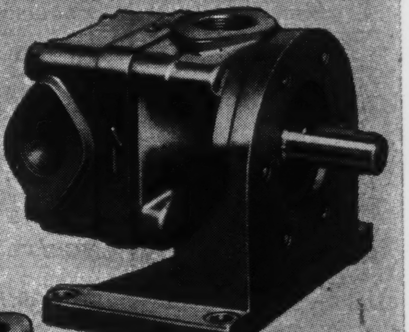
Hydraulic Balance . . . an exclusive feature of Vickers Vane Type Pumps for many years . . . eliminates pressure-induced bearing loads, providing longer life and less maintenance.

These Vickers Pumps are available in three basic sizes (shown at right) with a total of ten nominal delivery ratings and a variety of mountings. By unbolting and rotating the pump head the outlet may be placed parallel, opposite, or at right angle in either direction to the inlet. This greater adaptability to individual requirements means easy and inexpensive installation.

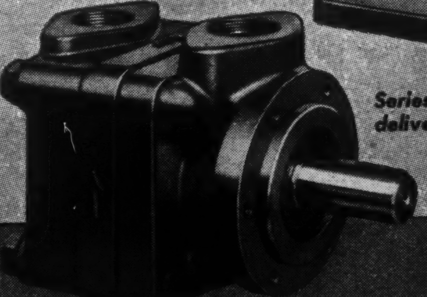
For additional information about these pumps (also double pumps) write for new Catalog M-5100. There is a Vickers Application Engineer near you who will be glad to discuss your hydraulic pump problems.



Series V-200 pump made in 4 delivery ratings—2 to 11 gpm.



Series V-300 pump made in 4 delivery ratings—12 to 24 gpm.



Series V-400 pump made in 2 delivery ratings—28 and 36 gpm.

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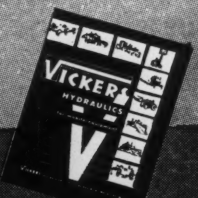
Application Engineering Offices: ATLANTA • CHICAGO (Metropolitan) CINCINNATI • CLEVELAND • DETROIT • HOUSTON • LOS ANGELES (Metropolitan) • NEW YORK (Metropolitan) • PHILADELPHIA • PITTSBURGH ROCHESTER • ROCKFORD • ST. LOUIS • SEATTLE • TULSA WASHINGTON • WORCESTER

ENGINEERS AND BUILDERS OF OIL HYDRAULIC EQUIPMENT SINCE 1921



Ask for **New Catalog M-5100**

FELT! BY THE YARD
FELT! BY THE ROLL
FELT!
IN CUT PARTS
WE MAKE IT . . . WE CUT IT . . . WE SELL IT . . .

All grades
All colors
All textures
All thicknesses
All consistencies

Precision cut felt parts is a *special* part of our business. With your first order you'll know we mean precision. For your parts will be engineered to your exact specifications . . . just the way you've always wanted to receive them. Write for details today.

THE FELTERS COMPANY
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Offices: New York, Philadelphia, Chicago, Detroit, St. Louis
Sales Representative: San Francisco
Mills: Johnson City, New York; Millbury, Mass.; Jackson, Mich.; New York City

Makes the Felt for the Parts it Cuts

of the Bureau's fiftieth anniversary. A feature of the ASA annual meeting at the Waldorf-Astoria in New York was the presentation of a scroll congratulating the Bureau "on a half-century of service in the public interest and in the improvement of the standard of American life." ASA president, T. D. Jolly, made the presentation to Dr. A. V. Astin, NBS acting director.

◆

American Society of Tool Engineers has announced its second annual scholarship awards contest to aid students in their fourth or fifth year who are taking subjects coming under the general category of "Tool Engineering". Five scholarships of $300 each will be awarded, four to students in the United States and one to a Canadian student. Application for scholarships must be made not later than March 1, 1952. Detailed information and applications are available from ASTE headquarters, 10700 Puritan Ave., Detroit 21, Mich.

◆

The **American Society for Engineering Education** is issuing a call to industry, the professional societies, public or private research organizations, and the engineering colleges for teaching aids which may be reviewed in its forthcoming Catalogue of Teaching Aids. The first edition will be limited to motion picture films (sound and silent), slides in 2 x 2 in. or 3¼ x 4 in. size, models, charts, and exhibits. Information on such devices should be sent to Professor Carl W. Muhlenbruch, Chairman, ASEE Committee on Teaching Aids, Northwestern Technological Institute, Evanston, Ill.

◆

New officers of the **National Association of Relay Manufacturers** are: President, H. L. Huntsinger, Essex Wire Corp.; vice president, R. T. Fisher, Sigma Instruments Inc.; and secretary-treasurer, J. B. Roughan, Price Electric Corp. The new board of directors, which is made up of company members rather than individuals, is as follows: Struthers-Dunn Inc., Allied Control Co., Automatic Electric Mfg. Co., Guardian Electric Co., Price Electric Corp., Leach Relay Co., and Potter and Brumfield Mfg. Co.

◆

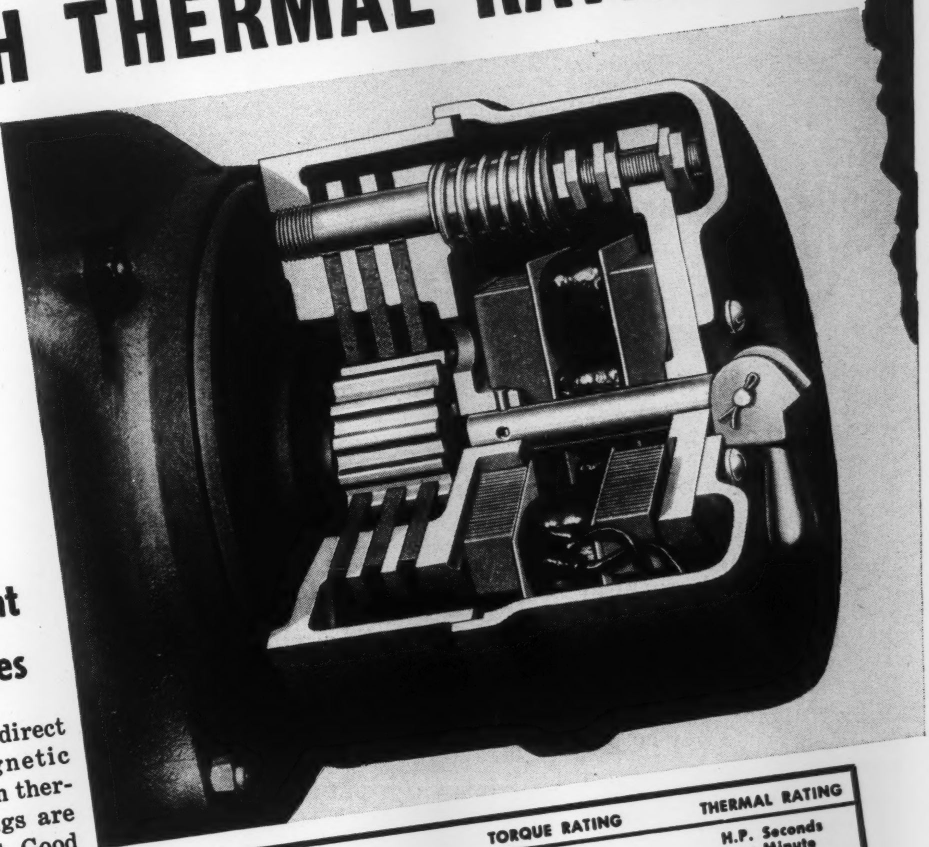
Newly incorporated is the **Association of Bearing Specialists,** a national organization of concerns whose primary purpose is supplying ball and roller bearings to the industrial trade

NEW DINGS MAGNETIC BRAKES HAVE HIGH THERMAL RATINGS

DIRECT-ACTING FOR AC OR DC MOTORS

●

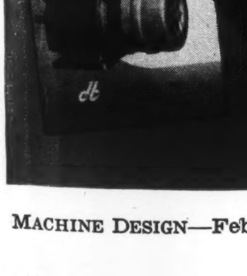
Designed to Mount on Nema C Flanges



The new line of Dings direct acting, disc type magnetic brakes offers new highs in thermal ratings. These ratings are listed in the table at right. Good heat dissipation characteristics contribute greatly to the ability of the magnet coils to operate on a 24 hour per day basis without overheating. The combination of high thermal ratings and cool magnet operation increases the trouble-free life expectancy of Dings brakes.

	TORQUE RATING		THERMAL RATING	
			H.P. Seconds per Minute	
For NEMA Motor Frame	Lbs., Ft.	Duty	Cont. or Inter.	60 Minutes
203C-254C	10	Cont.	10	....
203C-254C	15	Inter.	10	15
203C-254C	25	Cont.	12	....
284C-326C	25	Cont.	14	....
284C-326C	35	Inter.	14	21
284C-326C	50	Cont.	16	....
284C-326C	75	Inter.	16	24
284C-326C	75	Cont.	18	....
284C-326C	90	Inter.	18	27

There is no solenoid nor mechanical linkage between the magnet and the pressure plate. Spring tension engages the brake. Direct magnetic pull on the armature releases it. The brake is ruggedly constructed, compact, easily accessible for maintenance and is designed to mount easily on Nema Type C motor flanges. In adjusting, it is impossible for the operator to increase the torque beyond the ability of the magnet to release. An external manual release lever is incorporated. This mechanism automatically resets itself. For complete details, send for the new Brake Bulletin.



FREE BULLETIN ON REQUEST
All About Dings Brakes
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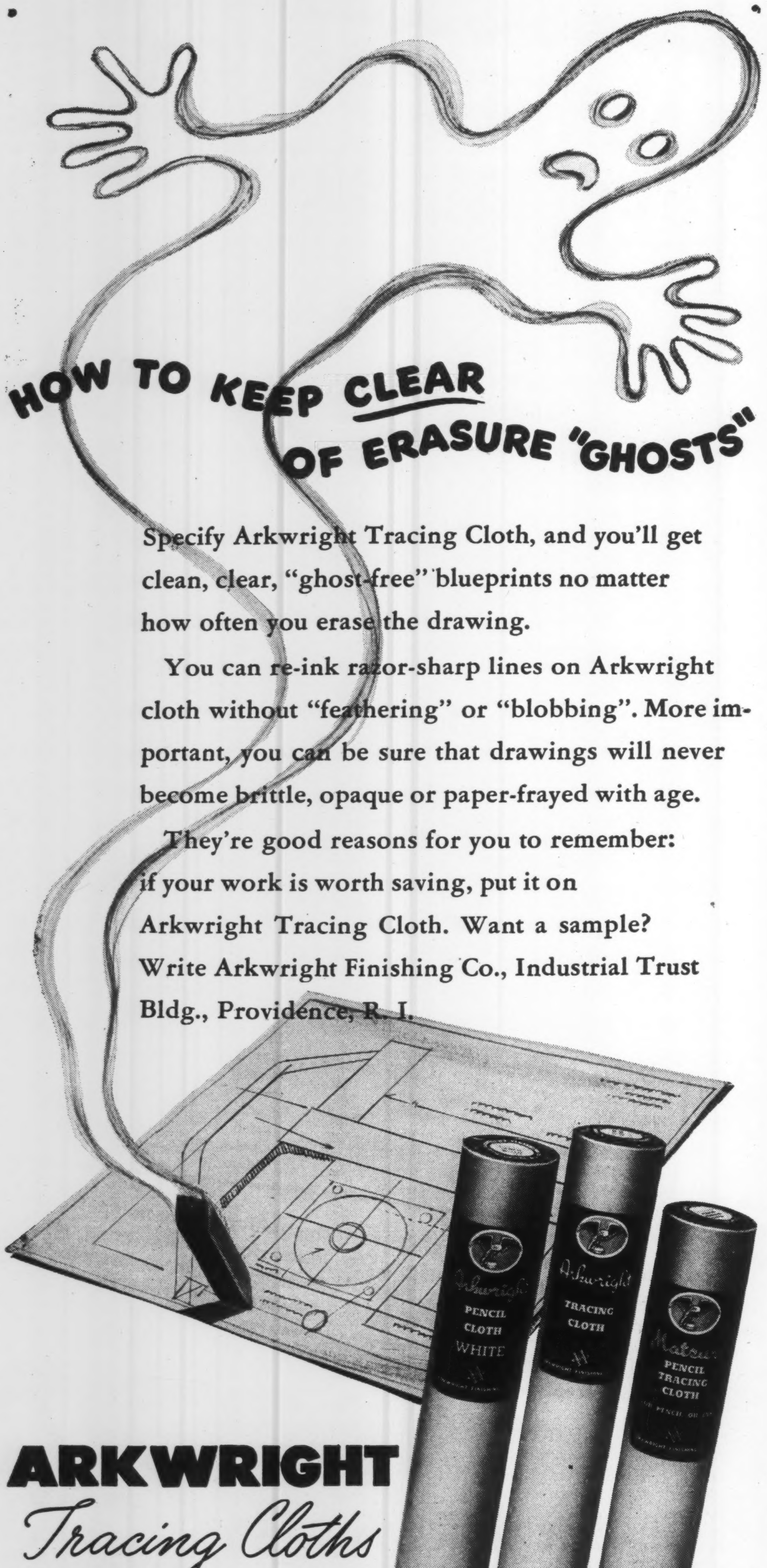
Write today

DINGS BRAKES, INC.
4714 W. Electric Ave., Milwaukee 46, Wis.
A Subsidiary of DINGS MAGNETIC SEPARATOR CO.
World's Largest Exclusive Builders of Magnetic Separators, Lifting Magnets and Magnetic Specialties


HOW TO KEEP CLEAR OF ERASURE "GHOSTS"
Arkwright PENCIL CLOTH WHITE
Arkwright TRACING CLOTH
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Specify Arkwright Tracing Cloth, and you'll get clean, clear, "ghost-free" blueprints no matter how often you erase the drawing.

You can re-ink razor-sharp lines on Arkwright cloth without "feathering" or "blobbing". More important, you can be sure that drawings will never become brittle, opaque or paper-frayed with age.

They're good reasons for you to remember: if your work is worth saving, put it on Arkwright Tracing Cloth. Want a sample? Write Arkwright Finishing Co., Industrial Trust Bldg., Providence, R. I.

ARKWRIGHT
Tracing Cloths
AMERICA'S STANDARD FOR OVER 30 YEARS

for maintenance. William F. Chase, Bearing Service Co., was named chairman of the board for the new Association at its first meeting in the Shamrock Hotel, Houston, Texas. Officers elected were: President, J. R. Gelomb, Iowa Bearing Co.; vice president, Gene Tappero, Michigan Bearing Co.; secretary, W. S. McClendon, Behrings Bearing Service, Inc.; and treasurer, Harold E. Johnson, General Bearings Co. Board members are; G. W. Elftman, General Bearings Co.; J. Hudson Crockett, Standard Machine and Supply Co.; Frank J. Stevens, Bearing Distributors, Inc.; J. K. Weiser, Minnesota Bearings Co.; and W. S. McClendon.

◆

Effective Jan. 1, 1952 the correct mailing address for both the **Abrasive Grain Association** and the **Grinding Wheel Institute** is 2130 Keith Building, Cleveland 15, Ohio.

◆

Harvey T. Harrison, The Duraloy Co., has been elected president of the **Alloy Casting Institute.** Also elected were: R. H. English, Blaw-Knox Co., as vice president and W. H. Worrilow, Jr., Lebanon Steel Foundry, as a member of the board of directors.

◆

At the 59th Annual Banquet of the **Society of Naval Architects and Marine Engineers** the following awards were made to members and visitors.

David W. Taylor Medal to C. Richard Waller, De Laval Steam Turbine Co., for notable achievement in marine engineering.

Captain Joseph H. Linnard Prize to E. F. Hewins, Newport News Shipbuilding and Dry Dock Co. and to Harold J. Chase and A. L. Ruiz of the General Electric Co., for their paper, "The Backing Power of Geared-Turbine-Driven Vessels."

President's Award to Mark L. Ireland Jr., M. D. Wheeler, and L. E. Spencer of the Newport News Shipbuilding and Dry Dock Co. for their paper, "The Performance and Design of Machinery for the 26,800-ton Esso Supertankers."

"M. C. James Memorial Medal", on behalf of the North East Coast Institution of Engineers and Shipbuilders of England, to Captain Ralph K. James, USN, in recognition of his paper read at Newcastle-upon-Tyne during the International Conference of Naval Architects and Marine Engineers held in Britain.

Fifty-Year Membership Certificates to George H. Bates, Horace Holden Thayer, Charles C. West and Rear Admiral Henry Williams, USN (retired).

SPONGEX®

cellular
rubber

Prevents Frosting And Sweating

"A-P Valve Insulator courtesy of A-P Controls Corporation, Milwaukee, Wisconsin."

Custom molded in one piece, Spongex cover opens, snaps closed around valve.

When this expansion valve is installed outside of low temperature apparatus a custom molded *Spongex* insulator prevents dripping which otherwise would damage the floor or equipment beneath. Besides its special shape the requirements of this part called for cellular rubber of interconnecting cell structure with natural skin on all exposed surfaces.

For many manufacturers, conversion is bringing new and different requirements for materials. Your needs in cellular rubber might call for **SPONGEX** similarly molded. Or a die-cut shape. Or a standard cord, tube, strip or sheet. Perhaps you seek the 0.28-0.30 K insulating factor of **SPONGEX CELL-TITE®** or the efficiency of **SILICONE SPONGEX** at –100° F to 450° F Spongex stands ready to help you solve any problems you may have.

This new booklet on the properties of, test data on, and specifications for cellular rubber is a concise, valuable reference source. Write for a free copy today.

CELLULAR RUBBER

SPONGEX

The World's Largest Specialists in Cellular Rubber.

THE SPONGE RUBBER PRODUCTS COMPANY

500 DERBY PLACE
SHELTON, CONNECTICUT

MORE THAN 27,000

THERE IS AN EASY WAY TO CONTROL VIBRATION

The easiest way to solve your vibration problem is to put it up to your nearest Lord Field Engineer. He will analyze it and recommend the specific type of Lord Mounting necessary. By drawing upon complete data files of more than 27,000 Lord Mountings and their variations, it is probable that he can solve your problem from this reservoir of available Lord Mountings.

If your vibration trouble involves circumstances which have not been encountered before, your Lord Field Engineer will work closely with you and with engineers at the Lord Factory to design the type of specific Lord Mounting most profitable to you.

For immediate attention to your problem call or write to

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LORD BONDED RUBBER

HEADQUARTERS FOR
VIBRATION CONTROL MOUNTINGS
. . . BONDED RUBBER PARTS

SALES AND SERVICE
Personnel

PROMOTIONS of four members of the sales division of The Cleveland Graphite Bronze Co., Cleveland, were announced recently by **L. W. Christenson,** vice president of sales. **Charles A. Williams,** who has been assistant to Mr. Christenson, is now sales manager of the original equipment division. **Robert E. Mooney,** district sales manager at the Detroit office since 1948, has been named district sales manager for the Ohio territory and will also handle special assignments for the sales division. He is succeeded as Detroit sales manager by **Wilmer D. Cowgill,** who has served as Detroit sales representative since 1939. **Starr W. Pearn,** a member of the engineering division field service staff, has been named Detroit sales representative.

◆

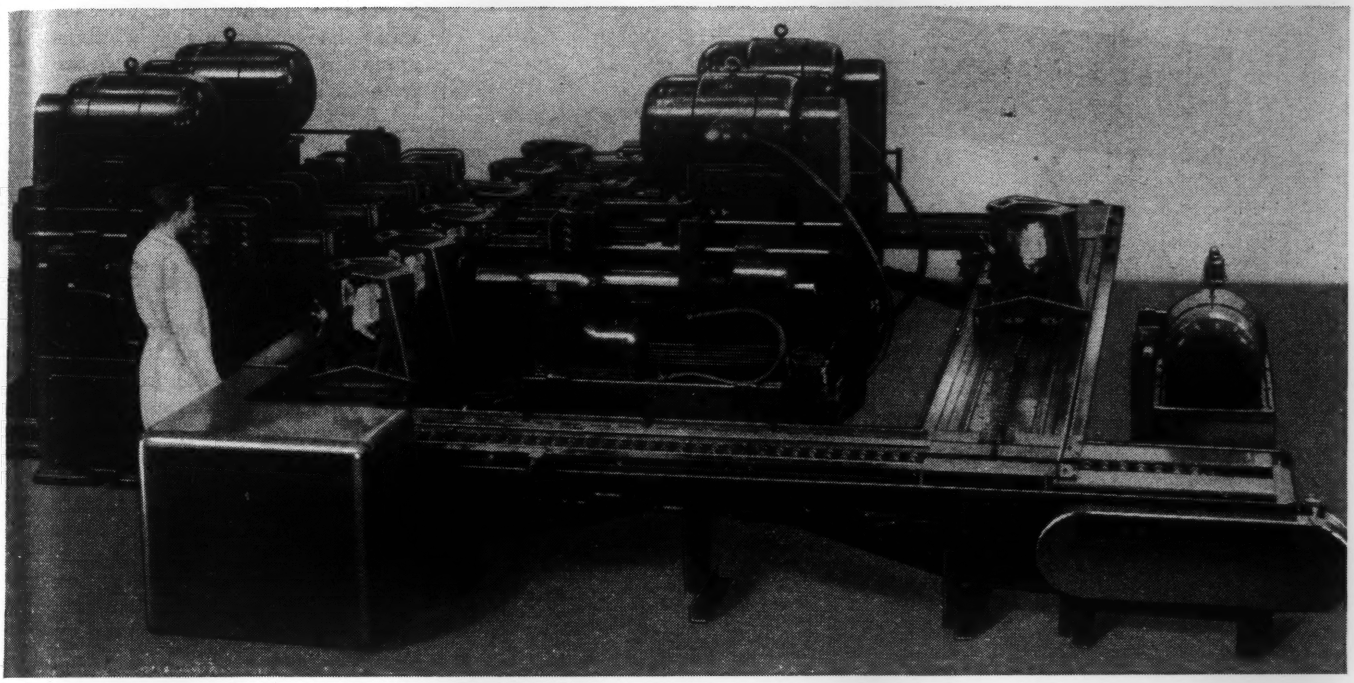
Announcement was made recently of the appointment of **Alfred J. Fava** as sales director of the General Products division of American Machine and Foundry Co., New York. Since 1945 Mr. Fava has served as sales manager of the Lowerator division, which is now a department of the General Products division. New sales manager of the Lowerator department is **J. J. Cranmore,** who has been sales manager for this department in the Chicago area. Mr. Cranmore is succeeded by **J. B. Moloney,** a member of the Chicago sales staff.

◆

Frank J. Bretzing has been appointed sales manager of the Rosan division of Bardwell & McAlister Inc., Burbank, Calif. He was formerly supervisor of quality control for the division.

◆

Raymond E. Olson, recently elected president of the Taylor Instrument Companies, Rochester, N. Y., has announced several major changes in the supervision of the sales department. Appointed to replace Mr. Olson as general sales manager is **Frank S. Ward,** who has served as industrial sales manager since 1945. Mr. Ward is succeeded by **Albert J. Fleig,** who has been divisional manager in charge of sales to the chemical, petroleum and canning industries. **George E. Heller** has been named manager of a new industrial sales division handling products sold to



Cross Transfer-matic, with 10 Howell motors, helps speed aircraft production.

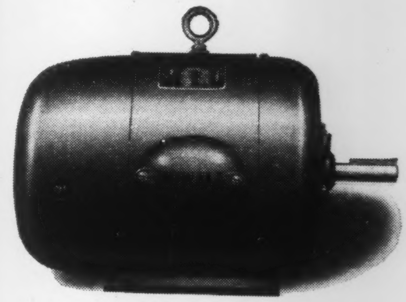
Drills, bores 80 cylinder heads per hour!

This Cross Transfer-matic drills and bores 80 aircraft engine cylinder heads per hour! That means a lot of engines for military or civilian planes.

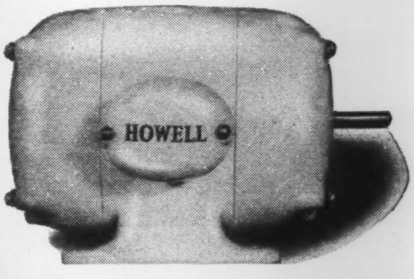
Built for one of the industry's leading manufacturers, this machine automatically rough drills and forms valve pockets and spring compartments, and finish bores valve guide holes and valve insert and spring seats. The whole operation takes only 45 seconds!

Ten precision-built Howell motors, ranging in size from one to 30 H.P., were specified to drive the spindles, the hydraulic and coolant pumps, and the chip and fixture conveyors. Each Howell motor was chosen to fit its job exactly.

Howell engineers will be glad to work with you, too, to get top performance from your electric motor installations. They will design special motors if required, or recommend Howell motors in standard NEMA frame sizes from 1/6 to 200 H.P. So, for every job, especially your toughest ones, get in touch with the Howell representative in your city, or write directly to us today.



HOWELL Type K Motor. Offers constant performance in the presence of dirt, dust, fumes and moisture. Sizes from 3 to 150 H.P. at 1800 R.P.M. Either vertical or horizontal mounting.



HOWELL Sanitary Motors meet the most exacting standards of the dairy and food industries. They contain no pockets, cracks, or crevices. Available for vertical or horizontal mounting.

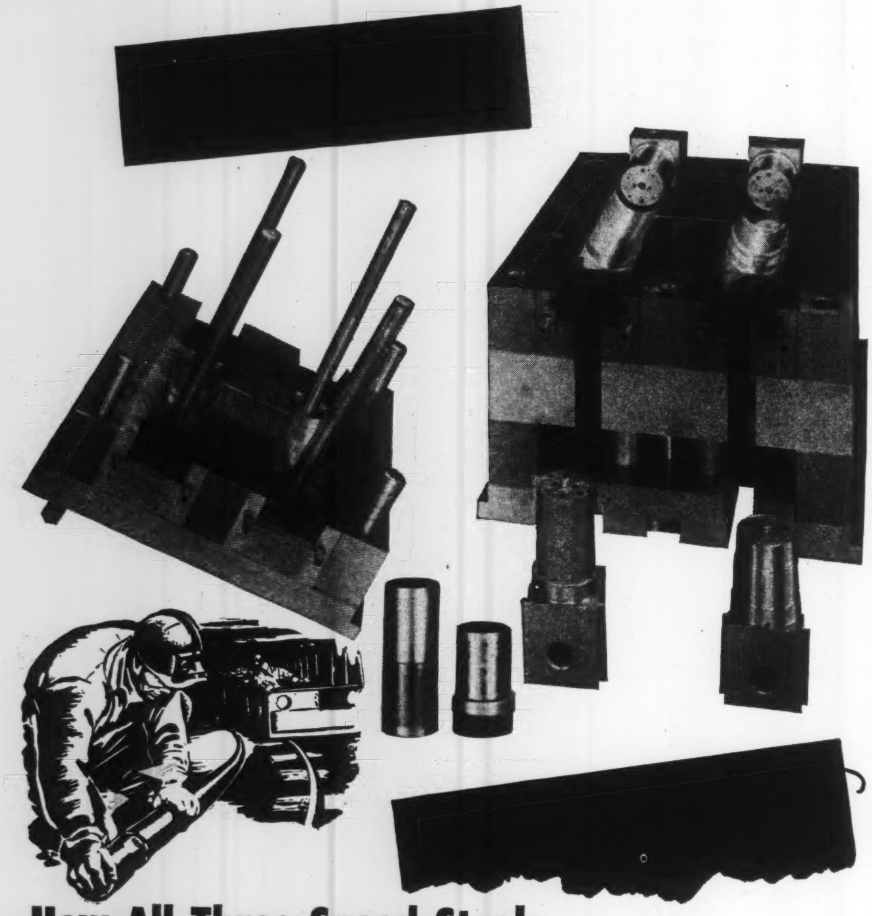
HOWELL ELECTRIC MOTORS COMPANY
Howell, Michigan

HOWELL
Red Band
MOTORS
®

HOWELL MOTORS

HOWELL ELECTRIC MOTORS CO., HOWELL, MICH.

Precision-built industrial motors since 1915



How All Three Speed Steels Make Plastic Pipe More "Flexible"

Carlon is a plastic pipe used to transmit fluids and vapors over irregular surfaces. This Speed Steel Mold—using Holliday's Speed Case (X1515), Speed Treat (X1545) and Speed Alloy hot rolled alloy plate steel helps make Carlon even more "flexible". It molds 6" dia. threaded plastic couplings that join either long lengths of Carlon to Carlon or Carlon to standard metal pipe.

Naturally, these couplings have to be near-perfect to prevent leakage. Carlon Products Corp. reports top distortion-free production at the rate of one shot per minute. Houk Machine Company, Barberton, Ohio who made the mold of Speed Steels for Carlon, reports 40% faster machining than regular hot rolled carbon or tool steels plus an absence of warpage and distortion and longer tool life. Top and bottom plates are of ground Speed Treat plate, male and female core are of Speed Case carburized to Rockwell 55 "C" then ground to size. Other parts are of Speed Alloy.

How versatile Speed Steels are solving new fabricating problems every day makes mighty profitable listening. Check with your Speed Steel distributor or write direct for literature.

SPEED STEELS

SPEED ALLOY ■ SPEED CASE ■ SPEED TREAT

DISTRIBUTED BY

Brown-Wales Co., Boston-Hartford-Lewiston, Me. ■ Bridgeport Steel Co., Bridgeport, Conn. Beals, McCarthy & Rogers, Buffalo, N. Y. ■ Burger Iron Co., Akron, Ohio ■ Grammer, Dempsey & Hudson, Inc., Newark, N. J. ■ Earle M. Jorgensen Co., Los Angeles-Houston-Oakland-Dallas ■ Passaic County Steel Service, Inc., Paterson, N. J. ■ Peckover's Ltd., Halifax-Montreal-Toronto-Winnipeg-Vancouver ■ Peninsular Steel Co., Detroit, Mich. Pidgeon-Thomas Iron Co., Memphis, Tenn. ■ Horace T. Potts Co., Philadelphia-Baltimore

Produced by W. J. Holliday & Co., Inc., Speed Steel Plate Division, Hammond, Indiana. Plants: Hammond and Indianapolis, Indiana

the chemical industry, and **Richard N. Pond** has been made a divisional manager to handle sales to the petroleum and canning industry.

◆

Jerome T. Coe, of the chemical division of General Electric Co., has been appointed customer service supervisor for silicone products, with offices in Waterford, N. Y. Another recent appointment in this division is that of **H. Arthur Howe** to manager of the Coshocton, O., plant. He formerly was manager of the phenolic products plant at Pittsfield, Mass., and is succeeded in that position by **Arthur T. Bourgault.**

◆

Field engineer with the Cleveland office of The Timken Roller Bearing Co., Canton, O., **Robert E. Cook** has been named to the position of sales engineer of the Steel and Tube division of that office. The company also recently appointed **R. G. Wingerter** as assistant general manager and **J. R. Splitstone** as district manager of its automotive sales division. Both men will continue to make their headquarters at the general automotive sales division offices in Detroit.

◆

J. R. Simpson & Co., Chicago representative for Conoflow Corp., Philadelphia control equipment manufacturer, has appointed **J. Robert Simpson III** as an associate. Mr. Simpson has served as a sales engineer for Conoflow Corp. for five years.

◆

The Electro-Snap division of the Exhibit Supply Co., Chicago, manufacturer of precision limit switches and electrical devices, recently appointed **George W. Ledbetter** as West Coast representative. Mr. Ledbetter will make his headquarters at the division's branch office located at 15117 Ventura Blvd., Sherman Oaks, Calif.

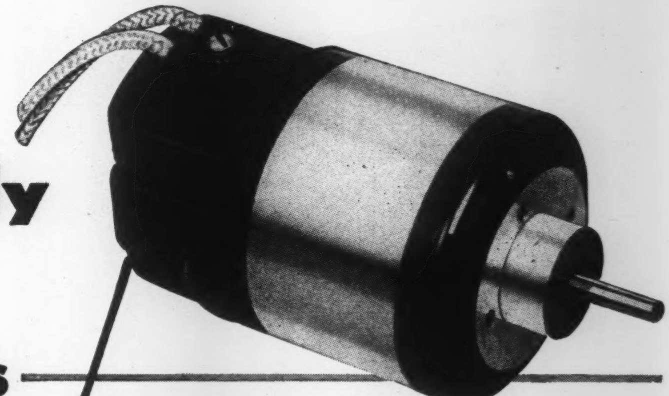
◆

The electronics components division of the Stackpole Carbon Co., St. Marys, Pa., has appointed **A. K. Neff** as sales manager. He has been associated with the company's home office sales department for a number of years. Other appointments include the promotion of **V. E. Gerber** to the position of assistant to the sales manager and **Don L. Almquist** to assistant to the manager.

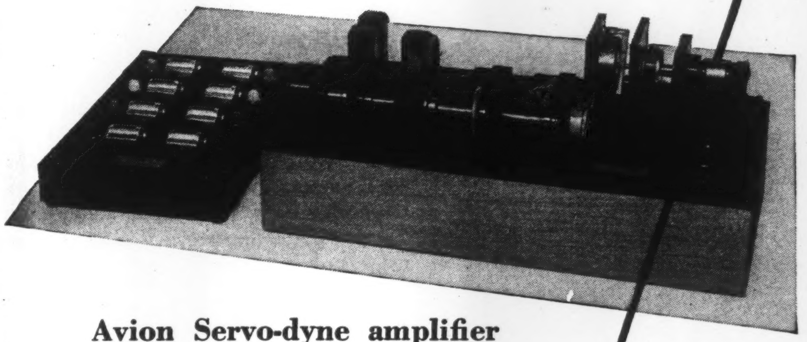
◆

Ampco Metal Inc., Milwaukee, has appointed **Nelson S. Cobleigh** as district manager of its Philadelphia sales division. Mr. Cobleigh has served as a field engineer in the Detroit of-

Developed especially for application in aircraft controls



the Holtzer-Cabot 0810
sub-miniature DC servo motor



Avion Servo-dyne amplifier

Holtzer-Cabot's RBDS-0810 sub-miniature DC servo motor was designed and engineered especially for service in highly sensitive aircraft controls and instruments.

A typical application of this special motor is its use with the Avion Servo-dyne amplifier. The sub-miniature combination of amplifier and motor reduces the size and weight of remote positioning systems in airborne computers and instruments indicating flight conditions.

The model 0810 performs efficiently at altitudes ranging from sea level to 40,000 feet, in temperatures varying from −65° F. to +160° F. and in relative humidity up to 100%. It is a 4-pole motor, measuring only 1⅝" in diameter and 2⁹⁄₁₆" over bearing hubs and weighs but 8½ ounces.

Operating on a normal field current of 6 milliamperes, the motor's armature is separately and continuously excited from a DC source of 24.3 to 29.7 volts. The field assembly consists of two independent high impedance windings, and this assembly is hermetically sealed.

The RBDS-0810 motor provides practically noiseless, variable-speed, reversible operation. It has a very low inertia rotating element for fast response, and delivers a maximum of 1/500 horsepower.

This achievement in small-motor efficiency is further evidence of Holtzer-Cabot's ability to develop and produce fine precision motors for exacting applications.

Specialized engineering skill combined with 75 years' manufacturing experience enable Holtzer-Cabot to build motors to the most demanding specifications.

For additional information write for Bulletin 0810.

HOLTZER-CABOT

DIVISION OF NATIONAL PNEUMATIC CO., INC.
BOSTON 19, MASSACHUSETTS
"Manufacturers of fine electrical apparatus since 1875"

fice for two and one-half years. **Ben R. Hecker** has been appointed as field engineer in the Detroit office. He has served as a resistance welding engineer in the Milwaukee office since 1949.

◆

Thomas R. Mahoney has been appointed a sales engineer for the Star Kimble Motor Division of Miehle Printing Press and Mfg. Co., Bloomfield, N. J. He will cover the northern New Jersey territory, working out of the headquarters office.

◆

J. R. Markey was recently appointed sales manager of the aircraft division of The Aro Equipment Corp., Bryan, O.

◆

Standard-Toch Chemicals Inc. has announced the appointment of **R. Coman Savoye** as sales representative for industrial product finishes in Massachusetts and Rhode Island. Mr. Savoye's headquarters are at Lexington, Mass.

◆

H. H. Hanft has been named assistant to the manager of the industrial department for Westinghouse Electric Corp., Pittsburgh. This department negotiates and co-ordinates sales and engineering information in the entire Westinghouse organization.

◆

Melvin J. Henry has been appointed general sales manager of the United Lacquer Mfg. Corp., Linden, N. J. He will supervise distribution, merchandising, market development and customer service.

◆

Fenwal Inc., Ashland, Mass., has appointed **Joseph P. Maguire** as sales representative for the state of Louisiana. Mr. Maguire's offices are located at 208-209 Vincent Bldg., 615 Commercial Place, New Orleans, La.

◆

Jackson Kemper has been appointed general manager of sales, distributor products division of Watson-Stillman Co., Roselle, N. J.

◆

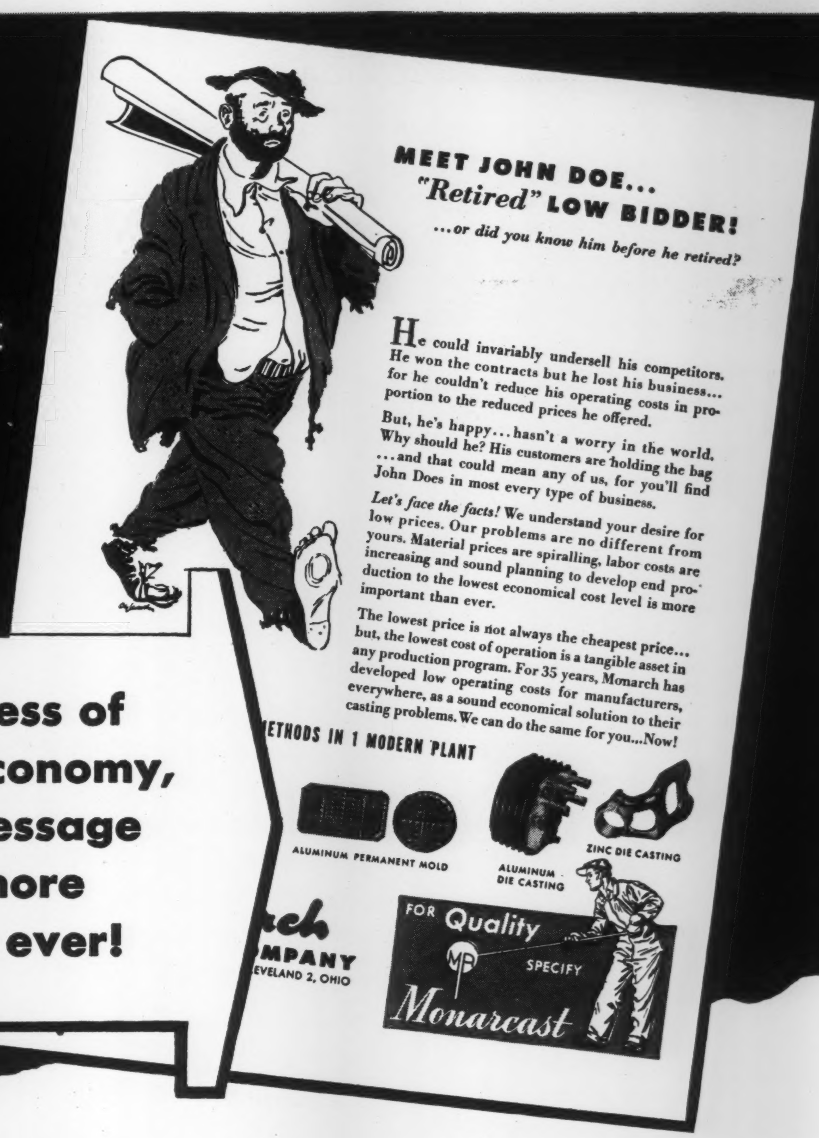
Newly assigned sales representatives to Allis-Chalmers Mfg. Co. general machinery division district offices are **Hugh C. Blair, John O. Higgins** and **Richard D. Miller.** Mr. Blair, formerly an application engineer in the transformer section, has been assigned to the New Orleans district office. Mr. Higgins is now in the firm's Houston, Tex., district office, and Mr. Miller has been assigned to the Birmingham, Ala., office. Another

Gearmaking
AT ITS FINEST!

HERE "under one roof" at FAIRFIELD is *everything* needed for producing fine gears — metallurgical department, batteries of the most modern machines, testing laboratories, complete heat-treating facilities — all operated by skilled craftsmen working under expert engineering supervision. By specializing exclusively in "FINE GEARS MADE TO ORDER" for more than thirty years, FAIRFIELD has become one of America's largest producers of these parts. This is why many makers of construction machinery . . . agricultural implements . . . machine tools . . . military equipment . . . tractors, trucks, and buses now regularly depend on FAIRFIELD to meet their requirements. *For the Best in Gears, Specify Fairfield!* FAIRFIELD MANUFACTURING CO., 311 So. Earl Ave., Lafayette, Indiana.

FAIRFIELD
For FINE GEARS

This Monarch advertisement originally appeared in July, 1948



MEET JOHN DOE...
"Retired" LOW BIDDER!
...or did you know him before he retired?

He could invariably undersell his competitors. He won the contracts but he lost his business... for he couldn't reduce his operating costs in proportion to the reduced prices he offered.

But, he's happy... hasn't a worry in the world. Why should he? His customers are holding the bag ...and that could mean any of us, for you'll find John Does in most every type of business.

Let's face the facts! We understand your desire for low prices. Our problems are no different from yours. Material prices are spiralling, labor costs are increasing and sound planning to develop end production to the lowest economical cost level is more important than ever.

The lowest price is not always the cheapest price... but, the lowest cost of operation is a tangible asset in any production program. For 35 years, Monarch has developed low operating costs for manufacturers, everywhere, as a sound economical solution to their casting problems. We can do the same for you...Now!

ETHODS IN 1 MODERN PLANT

rch
MPANY
EVELAND 2, OHIO

FOR Quality SPECIFY Monarcast

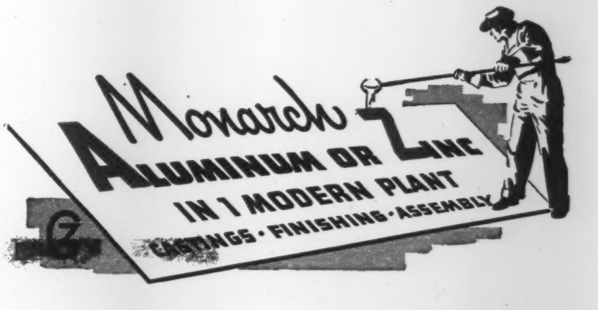
...Under the stress of today's unusual economy, the important message it conveys is more significant than ever!

RELIABILITY OF SUPPLIER SOURCES is one of the most important elements in any successful program of industrial production. Today's "guns and butter" economy proves it.

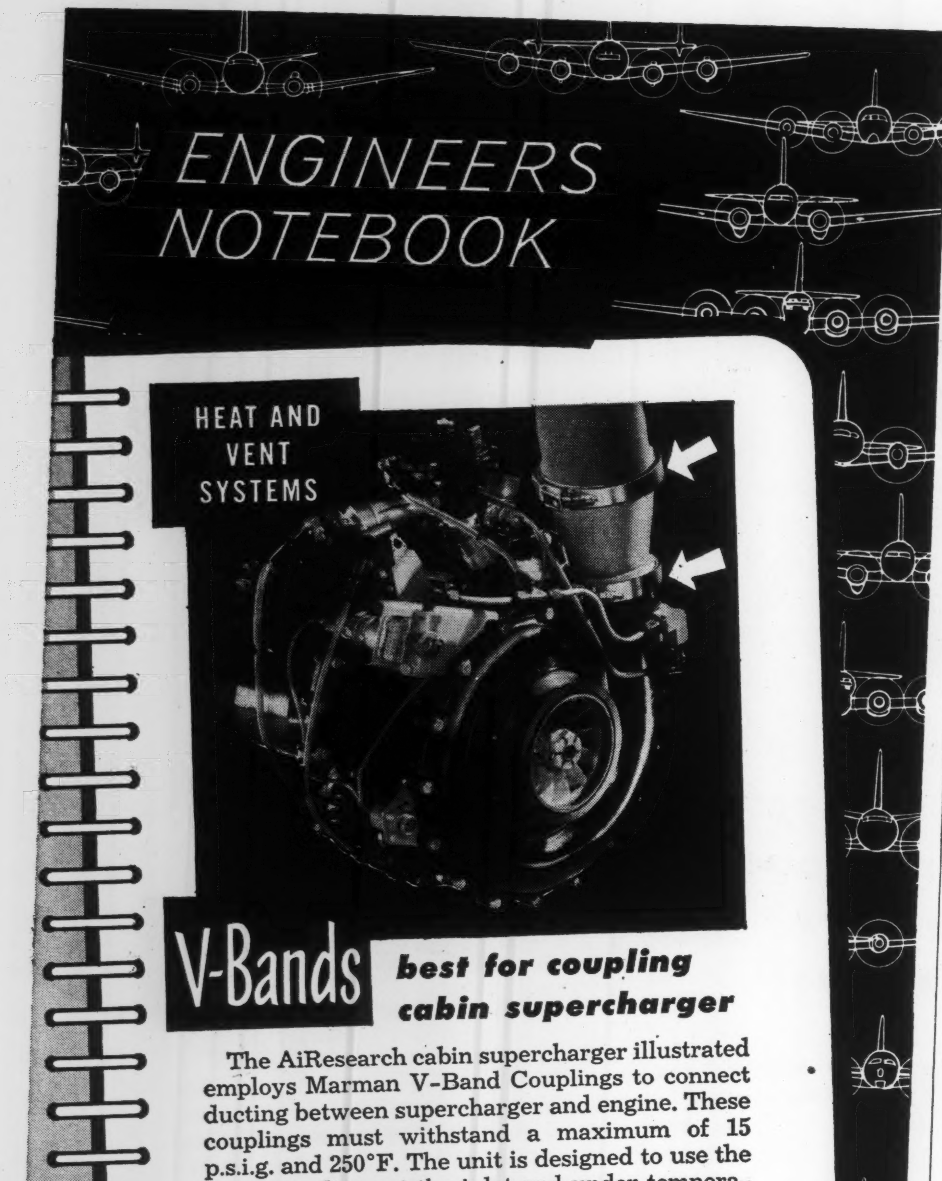
With 38 years of experience to call upon, Monarch is in an outstanding position to help any company whose current production requirements include aluminum permanent mold, aluminum or zinc die castings or complete sub-assembly work.

Monarch is ready to serve you now...with modern facilities and processes and people specially trained to provide practical solutions to industry's most complex casting problems.

Upon request, we'll send the complete "1948 series" of advertisements...also your copy of Monarch's FACT-FILE for design, production and purchasing executives.



MONARCH ALUMINUM MFG. COMPANY • ***Detroit Avenue at West 93rd Street, Cleveland 2, Ohio***



ENGINEERS NOTEBOOK

HEAT AND VENT SYSTEMS

V-Bands best for coupling cabin supercharger

The AiResearch cabin supercharger illustrated employs Marman V-Band Couplings to connect ducting between supercharger and engine. These couplings must withstand a maximum of 15 p.s.i.g. and 250°F. The unit is designed to use the same couplings at the inlet end under temperatures of –65°F. to +140°F. Max. In these and numberless other coupling applications the Marman V-Band provides great strength and a positive seal, light weight, and adaptability to a wide range of conditions, plus fast assembly and disassembly. Years of development have resulted in a standard line which fulfills virtually all requirements without special design...years of increasing use have created familiarity on the production line which results in great production savings.

Save Cost, Time and Weight with Marman

FOR INFORMATION, WRITE DEPT. M-2.

3-417
13

MARMAN PRODUCTS CO., Inc.
940 W. FLORENCE AVE.
INGLEWOOD, CALIFORNIA

newly appointed sales representative is **Leroy A. Sweinberg,** who has been assigned to the Wilkes-Barre district office.

◆

Synthane Corp., Oaks, Pa., has appointed **C. Leonard Johnson** as manager of its Rochester, N. Y. sales office to succeed the late **James P. Sill.** Mr. Johnson has been in charge of the company's branch office at Dayton, O., since April 1948.

◆

Fred Friedlieb was recently appointed sales manager of Admiral Die Casting Corp., Chicago.

◆

The Dow Chemical Co., Midland, Mich., has announced the appointment of **Fred A. Koch,** of the company's New York office, as special assistant to **Donald K. Ballman,** general sales manager. Mr. Koch has been associated with Dow since 1919.

◆

Formerly sales vice president, **John R. Hoover** has been elected president of B. F. Goodrich Chemical Co., in Cleveland. Mr. Hoover joined the Goodrich organization in 1925 as a chemist in the Akron works laboratories. His sales career began in 1932 when he was made assistant sales manager of the rubber-lined equipment department. He later became sales manager of that department and in 1942 assumed direction of plastics materials sales. When the B. F. Goodrich Chemical Co. was formed in 1944, Mr. Hoover was made general sales manager. He was elected vice president of sales in 1945.

◆

The Cooper-Bessemer Corp., Mount Vernon, O., has appointed **Roy W. P. Johnson** as a sales engineer in its New York district office.

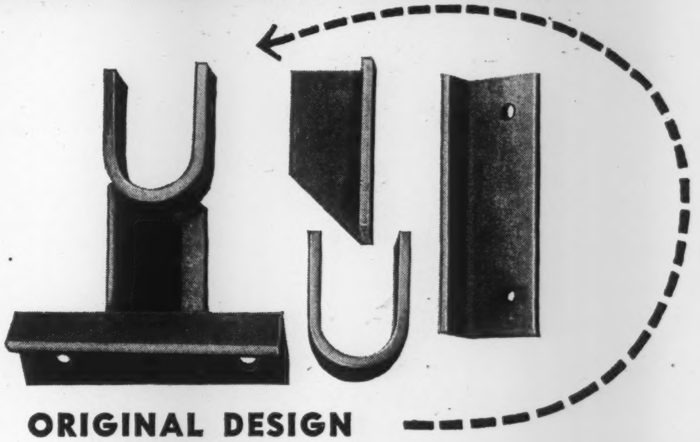
◆

A number of changes in the sales organization of Fairbanks, Morse & Co., Chicago, were announced recently. **J. A. Cuneo,** formerly manager of the Chicago branch, has been promoted to the position of general sales manager. **H. L. Hilleary** will continue as assistant sales manager. **Milo C. Roy,** formerly manager of the Omaha, Neb., branch, has been appointed manager of the Chicago branch. Succeeding Mr. Roy is **J. W. Wright,** who has been manager of the diesel sales division in Chicago. **C. E. Dietle** replaces Mr. Wright. **W. B. Wylly,** formerly manager of the Houston, Tex., sub-branch, has been appointed manager of the Atlanta, Ga., branch. **L. A. Weom,** who

Case History M-110

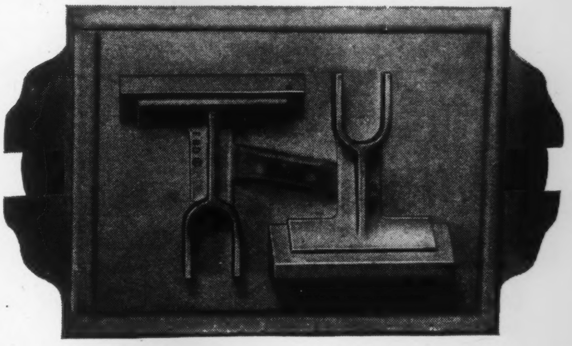
Here's what we mean by SUPERIOR ENGINEERED FOUNDRY PRODUCTS...

1. This bracket on an agricultural conveyor did not appear to be strong enough to give long-lived trouble-free service. Result? Sales resistance and loss of sales to competitors.
2. The production-cost, as a weldment made up from three pieces, was excessive.
3. It was difficult to attain dimensional stability during fabrication.
4. Weight, 3.1 pounds.



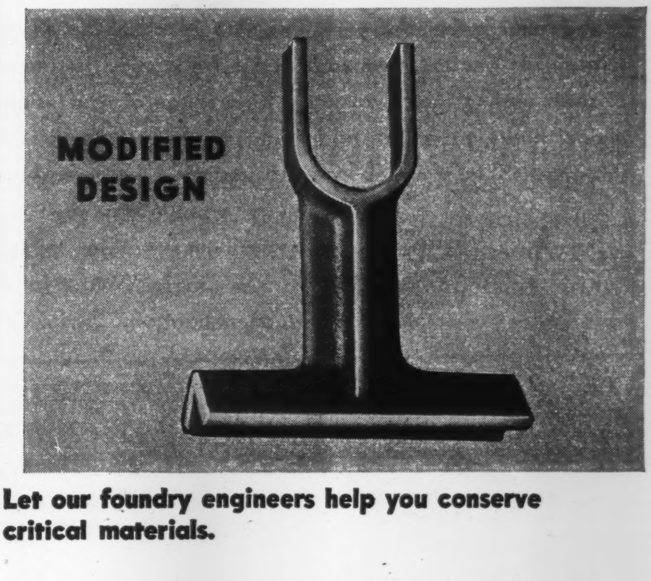
ORIGINAL DESIGN

A FOUNDRY ENGINEERED DESIGN one-piece steel casting which would require only simple, inexpensive pattern equipment and casting procedures.



BETTER APPEARANCE plus 10.5% Savings

1. Improved appearance and strength with a resultant improvement in sales.
2. 10.5% reduction in cost.
3. Dimensional stability which eliminated production difficulties.
4. Weight reduced to 2.7 pounds.



Let our foundry engineers help you conserve critical materials.

TOTAL COST OF PART REDUCED 10.5%

YOU, TOO, CAN GET SAVINGS LIKE THESE! CONSULT OUR PRODUCT DEVELOPMENT SECTION REGARDING YOUR PROBLEM... WHILE IT'S STILL ON THE DRAWING BOARD

Since 1916

SUPERIOR STEEL AND MALLEABLE CASTINGS CO.

BENTON HARBOR, MICHIGAN, U. S. A.

TO KEEP YOUR CASTINGS COMING . . . KEEP YOUR SCRAP GOING TO THE FOUNDRIES

Testing facilities
Field knowledge
Engineering experience
Factual data
On-the-job seal service
Materials selection

SHAFT SEALING
takes a lot of knowing

The tougher the rotary shaft sealing problem, the more likely it is to turn up at "Sealol". Our engineers have worked on almost every type of shaft sealing job, involving a wide range of shaft diameters, RPM's, temperatures, pressures, and fluids. It's this vast fund of knowledge — this practical information on shaft sealing — that's ready to go to work for you. When you have a sealing problem — regular or special — bring it to "Sealol". Write for data and recommendations. Sealol Corporation, 45 Willard Ave., Providence 5, Rhode Island. Plants #1 and #2 in Providence. Plant #3 in Keene, N. H. Offices in Philadelphia, Cleveland, Chicago, Los Angeles, Montreal, Toronto.

SEALOL
The Balanced Pressure Seal

had been manager of the St. Louis branch, has been transferred to St. Paul, Minn., as branch manager. An autonomous operation for the company's Electrical and Scale divisions has also been announced. With headquarters in Freeport, Ill., **Gordon R. Anderson** has been promoted to the position of general manager of the Electrical division. **W. H. Kingsley** is sales manager of this division. **George C. Worthley** has been named general manager of the Scale division, and **Joe Peterson** has been named sales manager of the division, with headquarters in Chicago.

◆

The appointment of **Robert A. Weisse** as assistant sales manager has been announced by The Kaydon Engineering Corp., Muskegon, Mich. Mr. Weisse joined the company early in 1951 as a sales engineer.

◆

E. H. Higginbotham has joined the southwest division of the Warner Electric Brake & Clutch Co., Beloit, Wis. As district representative of the firm, he will make his headquarters at 2214 N. W. 19th St., Oklahoma City, Okla. Mr. Higginbotham was formerly sales promotion director for the Batcheler Mfg. Co., Graham, Tex.

◆

The Permutit Co., New York, has announced the appointment of **Clyde R. Poore** as assistant sales engineer for its sales office located at 831 East Morehead St., Charlotte 3, N. C.

◆

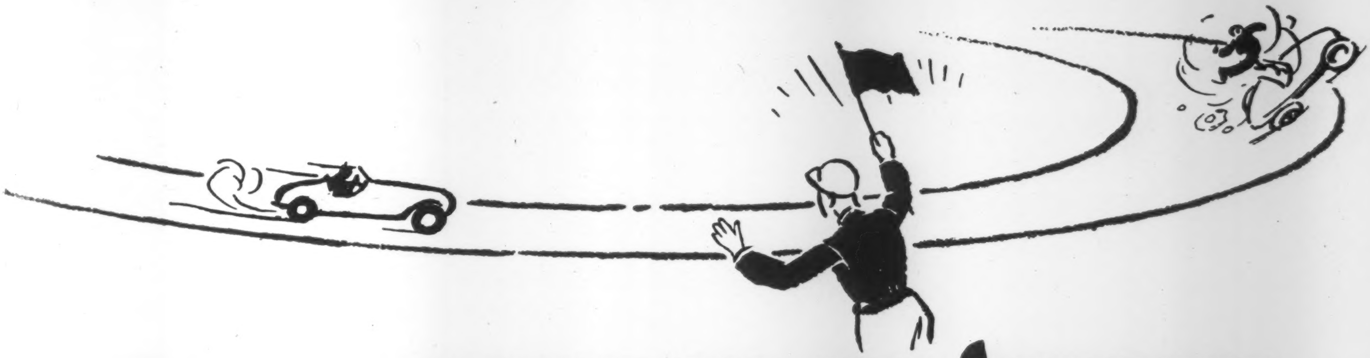
Alan H. Harris has been appointed products manager of the Phosphate Coating division of Detrex Corp., Detroit. During the past four years Mr. Harris has held the positions of sales representative, and sales and development technical co-ordinator. In his new position he will be in charge of the application of all Detrex phosphate coating materials.

◆

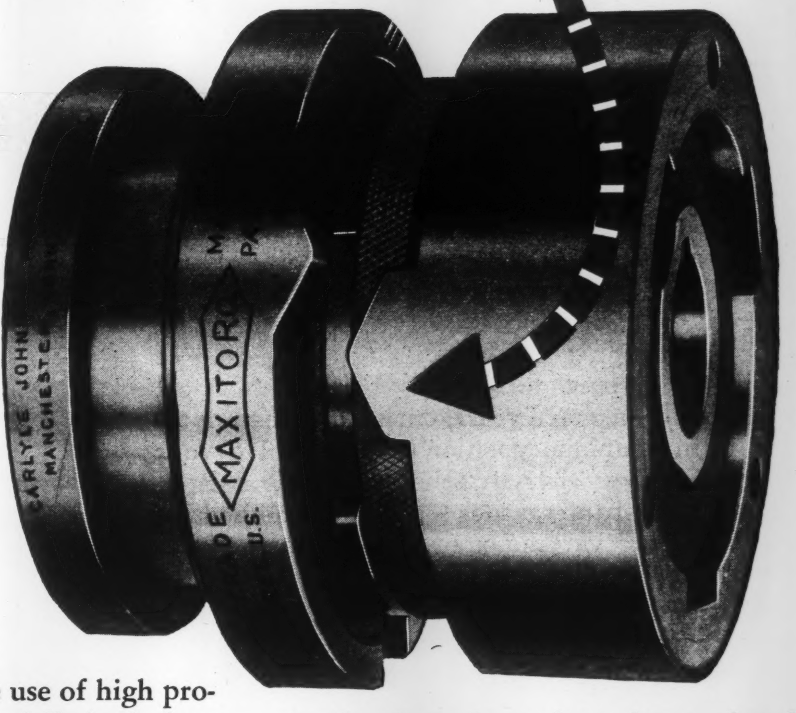
Ipsen Industries Inc., Rockford, Ill., recently announced the appointment of **George K. Lane** as district representative of its Cleveland and Pittsburgh territories. He is located at 15017 Detroit Ave., Lakewood, O.

◆

R. B. Hazard has been appointed sales manager of the Packing division of Raybestos-Manhattan Inc., Manheim, Pa. Mr. Hazard has served as representative for the B. F. Goodrich Co. in St. Paul, Minn.; W. S. Nott Co., Minneapolis; and the Anderson Crane Rubber Co., Minneapolis. Associated with Raybestos-Manhattan



INDUSTRIAL SPEEDWAYS, TOO, NEED PROTECTION



MAXITORQ *automatic* OVERLOAD RELEASE CLUTCH

The tremendous expansion in the use of high production automatic machinery, especially in the bottling, packaging, labeling, wrapping and kindred fields, calls for added protection thru safety controls in power transmission equipment.

For this purpose we offer the Maxitorq floating disc Overload Release Clutch which automatically and instantly releases when the nature of an overload is either a heavy shock or suddenly applied load of a magnitude substantially greater than normal driving load. In such instances the machine mechanism may be clogged, products damaged and operator injured…all of which means expensive down-time.

The Overload Release Clutch performs most effectively and prevents heavy overload destruction. When jammed condition is cleared the clutch is re-engaged and operation continues. Simple fingertip adjustment sets the clutch to transmit normal running load. For original equipment, specify Maxitorq. There are six standard capacities, 1/4 to 5 H.P. @ 100 r.p.m.

New catalog gives complete engineering specifications; shows complete line of standard clutches and driving cups.

ASK FOR CATALOG No. MD2

MAXITORQ

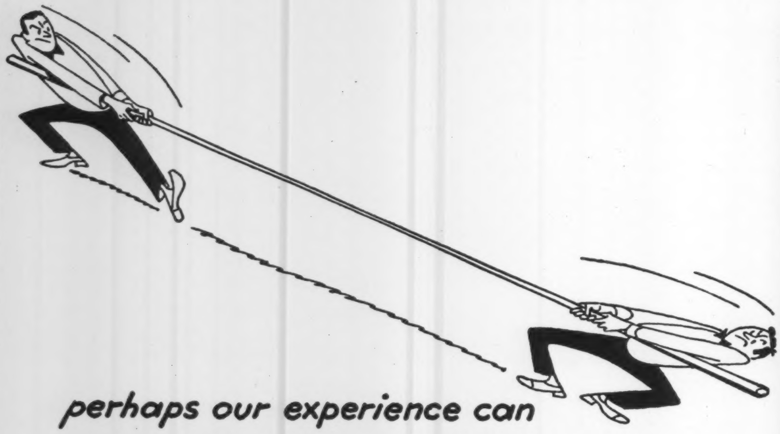
floating disc

INSTALLATION and DATA BOOK No. 51

THE CARLYLE JOHNSON MACHINE COMPANY

MANCHESTER • CONNECTICUT

1CJ52



OVER ONE HUNDRED YEARS OF CONTINUOUS SERVICE. ROUNDS, SQUARES, FLATS, HEXAGONS, OCTAGONS

BILLETS AND FORGINGS FOR PRODUCTION, TOOL ROOM AND MAINTENANCE REQUIREMENTS

perhaps our experience can

STRETCH

your alloy steel supplies!

You have doubtless heard about "bar-stretchers." Have you ever seen one? Wheelock, Lovejoy has several — any one of which can help you stretch your alloy steel supply so that you can keep up your production schedules during this period of unavoidable shortages. Having been in the steel business for over 100 years, our staff of metallurgists is in a unique position to help solve your difficulties. Our "bar-stretchers" include suggestions for substitute grades — alternate methods of manufacture — varying your present methods of treatment — and many more!

A letter or phone call to your nearest Wheelock, Lovejoy warehouse will bring an experienced man to help you stretch your alloy steel supply.

And he will be delighted to be of service! *SCRAP is worth money, and every pound turned in means more steel for you — so get in the SCRAP!*

Write today for your FREE COPY of the Wheelock, Lovejoy Data Book, indicating your title and company identification. It contains complete technical information on grades, applications, physical properties, tests, heat treating, etc.

DATA SHEETS
ALLOY STEELS
HY-TEN
AISI
SAE

WHEELOCK, LOVEJOY & CO., INC.

Warehouse Service

CAMBRIDGE • CLEVELAND
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In Canada
SANDERSON-NEWBOULD, LTD., MONTREAL

HY-TEN and AISI

133 Sidney St., Cambridge 39, Mass. and Cleveland • Chicago • Detroit
Hillside, N. J. • Buffalo • Cincinnati

since 1945, Mr. Hazard represented the Asbestos Textile & Packing division in the Minneapolis-St. Paul area, transferring to the Manhattan Rubber division in 1948. In 1949 he was advanced to the position of manager of distributor sales for the western division of the Manhattan Rubber division, with headquarters in Chicago.

◆

White-Rodgers Electric Co., St. Louis, manufacturer of automatic controls for heating, refrigeration and air conditioning equipment, recently appointed **Richard H. Ewert** as general manager, office sales division. Mr. Ewert was formerly assistant sales manager and mechanical engineer of Illinois Gear and Machine Co., and more recently was staff engineer for Barco Mfg. Co., Chicago.

◆

The Dollin Corp., Irvington, N. J., die castings manufacturer, has appointed **Philip Dollin,** 209 Rosemary Lane, Germantown, Pa., as representative for the eastern Pennsylvania, Maryland and Delaware areas. Mr. Dollin's die casting experience includes various engineering, management and sales responsibilities at the Dollin plant, as well as sales representation work in the East.

◆

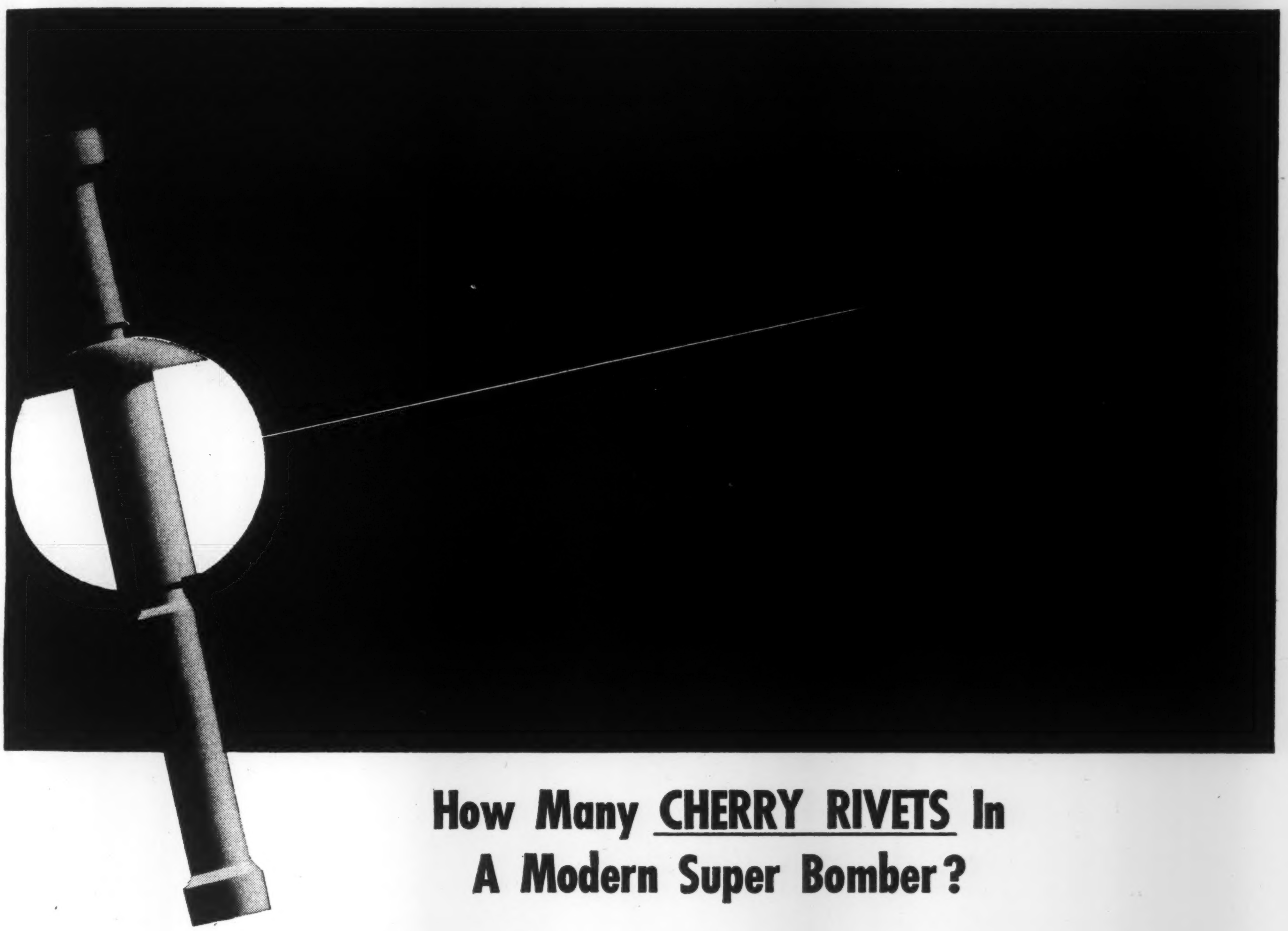
John Lund has been appointed district manager of Air Reduction Magnolia Co., a division of Air Reduction Co. Inc., New York. With headquarters at Shreveport, La., Mr. Lund will have sales responsibility for the Shreveport district. He joined the company's technical sales department in 1927.

◆

A. Milne & Co., New York, solid and hollow tool steel distributor, has announced the appointment of **James K. Hoyt** as assistant manager of its Pittsburgh office and warehouse.

◆

A general reorganization of sales territories and executive appointments have been announced by The Lunkenheimer Co., Cincinnati. The country has been divided into eastern, central, and western sales areas, directed by sales managers **Melvin W. Pauly, Harold H. Layritz** and **Charles W. Burrage,** respectively. **R. J. Sardieck,** with headquarters in Philadelphia, has been appointed district manager in the eastern division; **E. R. Tieberman** is district manager in the central division, with headquarters in Dallas, Tex.; and **C. B. Rosser Jr.** will serve as district manager in the western division, with headquarters in Los Angeles.



How Many CHERRY RIVETS In A Modern Super Bomber?

In aircraft construction, Cherry Blind Rivets are virtually indispensable. Their practicability is demonstrated by the fact that more than a quarter-million of these ingenious rivets help stitch various components of the modern super bomber — as many as sixty thousand are used in the construction of a four-engine transport. Their use makes possible refinements of design and assembly methods of control surfaces and other components that speed fabrication with big savings in unit costs.

The use of Cherry Blind Rivets has spread from aircraft construction to all industry. Designers and production engineers find them especially applicable in blind spots because Cherry Blind Rivets are installed by one man from one side of the work and eliminate the helper used to buck other types of rivets. Cherry Rivets are used in double-surfaced structures, box sections, tubes, ducts, and other hard-to-reach places. Their time and cost saving features are used to advantage in railroad cars, busses, trailers, household appliances, automobiles, and other equipment where reduction in assembly time can be substantial—where improvement in product is important.

Cherry Blind Rivets are one group in the Townsend family of fasteners which are used by all industry to fasten metal, plastics, wood, glass and fabrics together. As specialists in cold heading, Townsend engineers, with a complete line of fasteners and parts to draw upon, can better help solve your fastening problem by giving you an unbiased recommendation. If necessary they will design a special item to fit your individual need. For information on how you can speed production by improving your fastening efficiency, write your nearest Townsend plant or office.

Townsend

COMPANY • ESTABLISHED 1816

Plants—New Brighton, Pa. • Chicago 38, Ill.

Cherry Rivet Company Division, Los Angeles, California

Sales Offices in Principal Cities

THE FASTENING AUTHORITY—Experience: ***over 136 years*****—Capacity:** ***sixty-million parts daily*****—Products:** *over ten-thousand types—solid rivets—cold-headed parts—Cherry Blind Rivets—self-tapping screws—tubular rivets—locknuts—special nails—formed wire parts.*

HOW TO BUILD THE LUBRICATION PUMP INTO THE DESIGN OF YOUR MACHINES

Solve Space Problems with

TUTHILL *Stripped Pumps*

Here is a typical example of how a lathe manufacturer has saved space and streamlined the equipment by incorporating the Tuthill lubricating pump into the design of the headstock.

These dependable stripped pumping units are the practical answer where mounting space is limited or where it is necessary to install the pump in a special position on the machine.

Tuthill engineers pioneered the idea of incorporating stripped pumps directly into the design of the machine, and their long experience is available to you in helping work out new designs or changes in present equipment.

TYPES AND SIZES AVAILABLE

Tuthill Stripped Pumps are offered in two types as illustrated. Type S, furnished without mounting bracket, and Type SA, which provides pumping elements only. Capacities up to 200 g.p.m. in wide pressure ranges. Stripped pumps are also available in automatic reversing models for use where the pump must be driven by a reversing shaft without changing direction of flow.

Write for details on Tuthill Stripped Pumps or submit your problem for recommendation.

25th TUTHILL PUMPS FOR THE PURPOSE *Anniversary*

TUTHILL PUMP COMPANY

939 E. 95th Street, Chicago 19, Illinois

SALES
Notes

ESTABLISHMENT of a district sales office in New York has been announced by the Fiber Glass division of **Libbey-Owens-Ford Glass Co.,** Toledo, O. With offices in the General Electric Bldg., 570 Lexington Ave., Arnold K. McClay, who is in charge of the new office, will handle sales in the New England states, New York, Pennsylvania, New Jersey, Delaware and Maryland.

◆

The Chicago office of **The Hydraulic Press Mfg. Co.,** Mount Gilead, O., is now located at 3058 Peterson Bldg., Peterson Ave. Don C. Youngblood is district manager of this office.

◆

Metals Disintegrating Co. Inc., Elizabeth, N. J., manufacturer of metal pigments, powders and abrasives, has announced the appointment of two new distributors. The **Daniel G. Hereley Co.,** Chicago, will serve the northern parts of Illinois and Indiana, and **J. W. Copps** of Milwaukee will cover most of the state of Wisconsin, as well as the north peninsula of Michigan.

◆

Rigid vinyl plastic tubing, pipes, rods, sheets, blocks and molding compounds in the Boltaron 6200 series will be distributed by **H. N. Hartwell & Son Inc.,** Boston, according to an announcement by **Bolta Products Inc.,** Lawrence, Mass. The Hartwell company will offer complete engineering service to Boltaron fabricators and users. Training centers for fabricators have been established, and a complete warehousing service will be provided.

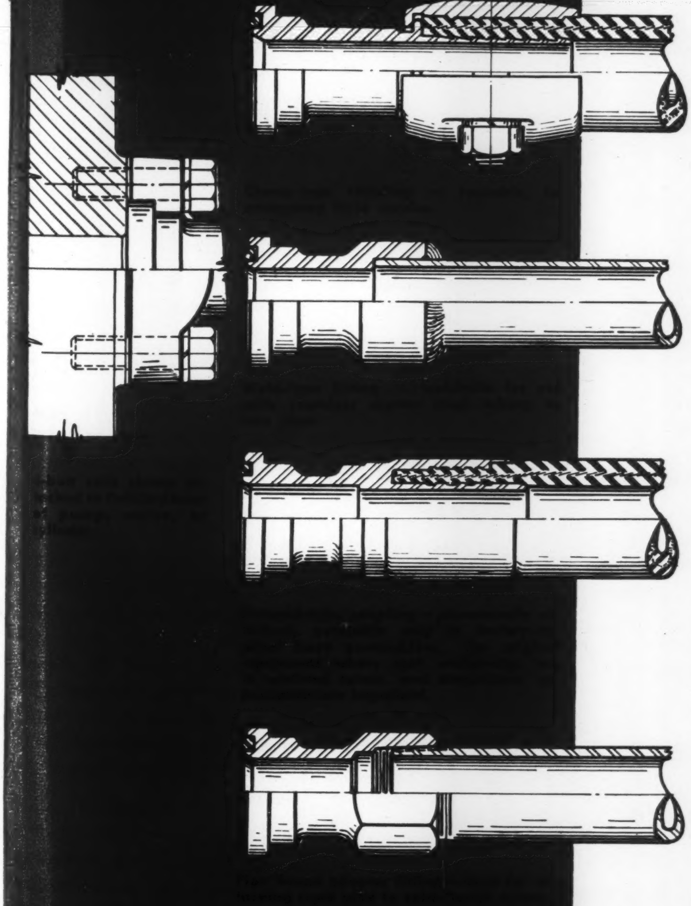
◆

Atlas Chain & Mfg. Co., Philadelphia, recently opened a New York office. Headed by Oliver J. R. Troup Jr., district manager, the new office is located at 250 West 57th St., Room 829A, New York 19, N. Y.

◆

The following distributors have been appointed by **Sterling Electric Motors Inc.,** Los Angeles: **Allied Bearings Supply Co.,** 822 South Boulder, Tulsa 5, Okla.; **Berry Electric Co.,** 301 South Third St., Walla Walla, Wash.; **Alabama Bearings Co. Inc.,** 7 Railroad St., Montgomery, Ala.; **Stanley Electric Motor Co.,** 1520 East Miner Ave., Stockton 5, Calif.; **Roy**

Stop Leaks... Eliminate Threaded Joints



in hydraulic hose assemblies

with this revolutionary, easy-to-use ANCHOR SPLIT-FLANGE CLAMP

Here's a brand new time- and trouble-saver for the users of hydraulic hose and piping — Anchor's exclusive Split-Flange Clamp. Check these features — they're what you've been looking for.

LEAKPROOF — the "O" ring, successfully utilized in so many hydraulic applications, provides a perfect seal.

EASY TO ASSEMBLE — no unwieldy pipe wrench required. All you need is a small automotive type wrench. Ideal where clearances are limited.

ELIMINATES PIPE THREADS — can easily be removed or attached over and over again. No tapered threads or wedging action to cause distortion in pump housings, cylinders, or valve bodies.

WIDE RANGE OF SIZES AND TYPES — straight or angle styles with clamp or pressed-on couplings — sizes from ½-inch ID to 2-inch ID. Available for high, medium, or low-pressure service and suction return lines. Send coupon for further information.

ANCHOR COUPLING CO. INC.
***Factory:* LIBERTYVILLE, ILLINOIS • *Branch:* DETROIT, MICHIGAN**

Tear out this coupon and mail today →

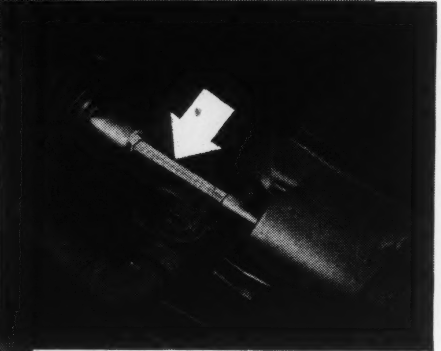
ANCHOR COUPLING CO. INC., Dept. MD22
Libertyville, Ill.

Yes, I'm interested in Anchor Split-Flange Clamps.
Please send me a bulletin with more information.

Name..Position........................
Company..
Company Address..
City..(..........) State........................

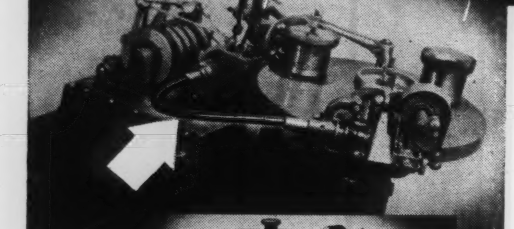
D-11

THESE POWER DRIVE PROBLEMS ARE "Duck Soup" FOR S.S.White flexible shafts



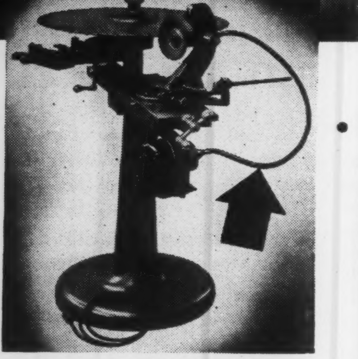
ALIGNMENT •

When alignment is a factor, as in this adjustable pulley drive on a large turret lathe, an S.S.White flexible shaft provides a positive vibrationless drive which functions efficiently even when the coupled spindles are not in alignment.



• CURVES

When power has to turn corners, as in this sock darning machine, a single S.S.White flexible shaft is all that's needed, because it's especially designed to transmit power in paths other than straight lines.



• ADJUSTABILITY

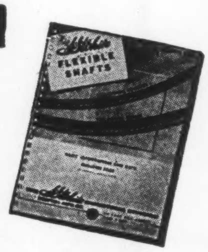
When a driven part has to be set in different operating positions, as the grinding wheel of this saw sharpening machine, the non-rigid construction of an S.S.White flexible shaft readily adapts itself to these changes.

S.S.White flexible shaft and casing combinations can be supplied in a wide range of diameters and physical characteristics in lengths to suit your requirements. S.S.White is ready to cooperate with you in working out the most suitable combination for your needs.

S.S.White MAKES IT RIGHT

WRITE FOR NEW BULLETIN 5008

It contains the latest information and data on flexible shafts and their application. Write for a copy today.



THE S.S.White DENTAL MFG. CO. INDUSTRIAL DIVISION

Dept. 4, 10 East 40th St.
NEW YORK 16, N. Y.

Western District Office • Times Building, Long Beach, California

A. Berentz Co. Inc., 1400 Carr, Houston 1, Tex.; **Industrial Electrical Co.**, 1244 McHenry Ave., Modesto, Calif.; **Butte Machinery Co.**, 510 East Aluminum, Butte, Mont.; **Pomona Electrical Machinery Co. Inc.**, 260 N. E. End Ave., Pomona, Calif.; **Industrial Motor Electric**, 449 West St., Woodland, Calif.; **Meyer Brothers Co.**, Phillipsburg, Pa.; and **Transmission Equipment Co.**, 527 Lexington Ave., New York 17, N. Y.

◆

The establishment of two new subsidiary companies has been announced by **Allied Research Products Inc.**, Baltimore. **Allied Metal Finishing Corp.** will assume responsibility for the job shop metal finishing business previously conducted by the parent organization. The other subsidiary, **Allied Research Sales Corp.**, was established to handle the national sales of Iridite metal finishes and ARP plating chemicals. The parent company will continue to manufacture both the Iridite and ARP compounds.

◆

The **Star-Kimble Motor Division** of **Miehle Printing Press and Mfg. Co.**, Bloomfield, N. J., has opened new branch sales offices in Milwaukee and Cincinnati. Lloyd Steinmetz will be in charge of the Cincinnati office, which is located in the Roselawn Center Bldg., and Robert L. Palmer will have charge of the Milwaukee office at 312 East Wisconsin Ave.

◆

An Indianapolis sales office has been opened by **Synthane Corp.**, Oaks, Pa., manufacturer and fabricator of laminated plastics. Duane W. Roland, who has been associated with the company's New York sales staff for the past three years, has been placed in charge of the new branch, which will serve customers in southern Indiana, southwest Ohio and Kentucky.

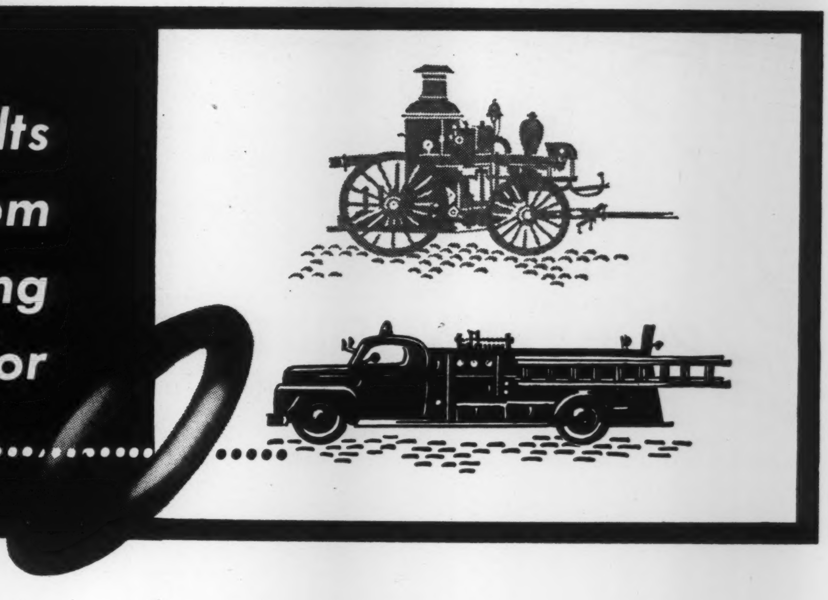
◆

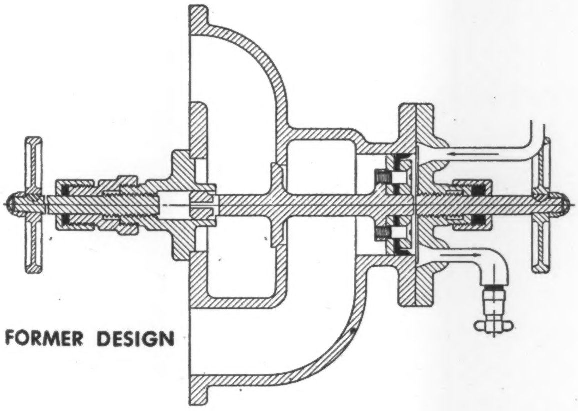
Stocks and warehouse facilities formerly owned by the Seattle Steel Co. of Seattle, Wash., and the Inland Empire Steel Co. of Seattle and Spokane, have been acquired by **Joseph T. Ryerson & Son Inc.**, Chicago. The company expects to add to the existing facilities and to enlarge the stocks of these steel service warehouses as soon as possible.

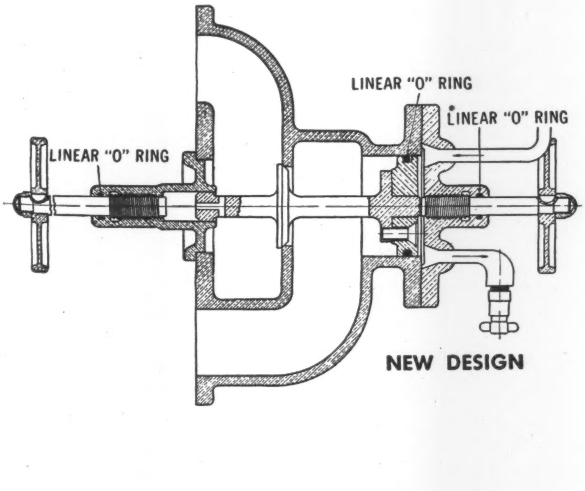
◆

Establishment of an electronics division to co-ordinate the manufacture and sale of flexible and rigid waveguides, electronic parts and special equipment has been announced by **Titeflex Inc.**, Newark, N. J., manufacturer of flexible metal tubing and

Results from designing for simplification..........







More power and less bulk—higher pressures and safer operation—greater speeds and less wear—more economical use of scarce materials . . . these are industry demands that every designer must meet—now!

Where simplification seems impossible because of sealing difficulties with—type of fluid handled, extent of pressures exerted, wide temperature changes, abrasion—have you considered the wide application possibilities of LINEAR "O" Rings?

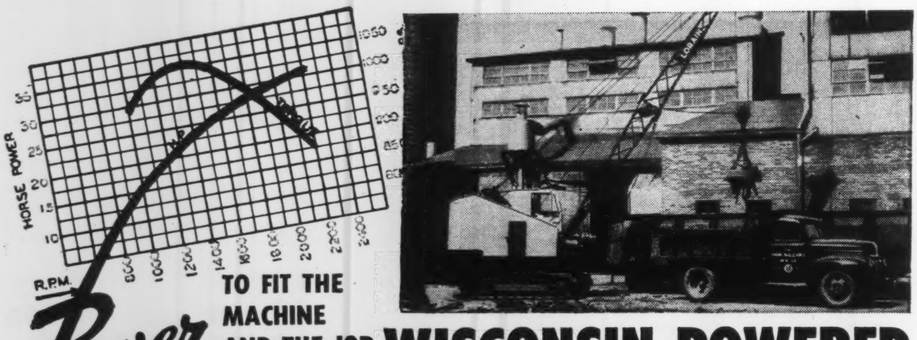
A typical example of how LINEAR "O" Rings make design simplification possible can be illustrated by this redesigned relief valve. Here, *valuable metal was saved—five parts were eliminated—weight was reduced—production costs were reduced 22.4% . . . and most important, the profit margin on each unit was substantially increased.*

To build it better—to make it simpler—to provide a greater profit margin per unit . . . let LINEAR help you with your packing and sealing problems.

"PERFECTLY ENGINEERED PACKINGS"

LINEAR

LINEAR, Inc., STATE ROAD & LEVICK ST., PHILADELPHIA 35, PA.



Power TO FIT THE MACHINE AND THE JOB

WISCONSIN-POWERED

Power Plants, Inc. Generator

Three carloads of scrap travel fast from freight cars to trucks every day with this crane on the job. It's equipped with a 36" ECM magnet, and the generator, built by Power Plants, Inc., Cleveland, Ohio, is powered by a Wisconsin Air-Cooled Engine.

Over and above time and labor saved through Wisconsin Engine dependability, servicing and maintenance are reduced to a minimum. For example, bearing failure is unheard of due to tapered roller bearings at both ends of crankshaft. Fool-proof air-cooling means no winter freeze-ups or summer overheating. And an easily-serviced OUTSIDE magneto with impulse coupling delivers all-weather quick starts. These features, combined with rugged construction, are the basis for the most dependable, most versatile power in the 3 to 30 hp. range . . . WISCONSIN POWER.

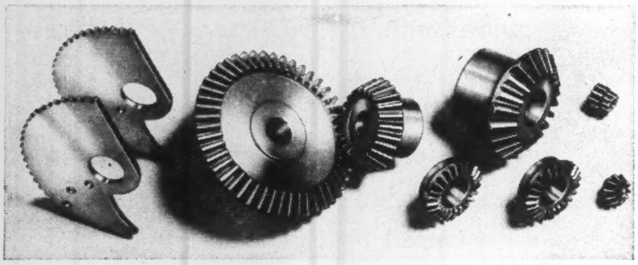
Write for details covering 4-cycle single-cylinder, 2-cylinder and V-type 4-cylinder models.

MOST H.P. HOURS

WISCONSIN MOTOR CORPORATION

World's Largest Builders of Heavy-Duty Air-Cooled Engines

MILWAUKEE 46, WISCONSIN



Rynel

fractional h.p.

Gears

For All Small and Medium-Sized Gear Applications

Controlled Blank to Finished Gear

Rynel Certified Gears are made exactly to your specifications. Accuracy, tooth form and finish are controlled from the start with accurately formed blanks from our own gear blanking department Experienced gear men cut true tooth forms with the latest precision equipment. Finished quality is checked by skilled gear inspectors. • That's why designers, engineers and product development men recognize Rynel Certified Gears for quality and dependability.

SPUR • HELICAL • WORM • WORM GEAR INTERNAL • SEGMENT • SPROCKET • RATCHET FINE PITCH • STRAIGHT-TOOTH BEVEL GEARS

Send For Our Latest Bulletin

Rynel Corporation

301 MILLER ST., STERLING, ILLINOIS

aircraft ignition harnesses. Robert G. Brazenor will direct the new division and William W. Buckley will assist as electronics sales supervisor; James Nickerson and John Bales have joined the staff as sales engineers.

◆

Gerity Magnesium Corp., wholly-owned subsidiary of **Gerity-Michigan Corp.**, Adrian, Mich., recently began to manufacture magnesium sand castings. The new division will specialize in producing large intricate magnesium castings for both jet and reciprocating aircraft engines. Peak production is expected to be reached by September.

◆

According to an announcement by **Cummins Engine Co. Inc.**, Columbus, Ind., the Chicago facilities of **Cummins Diesel Sales Corp.** hereafter will be operated as an independently owned dealership with the new name of **Cummins Illinois Engine Sales Inc.** Headquarters remain at 1700 South Indiana Ave., Chicago; the territory to be covered includes the 22 counties of northern Illinois; Scott County, Iowa; and Lake, Porter and La Porte counties in northern Indiana. Operations at Milwaukee and Peoria, Ill., formerly with headquarters at the Chicago dealership, now become individual dealerships of Cummins Diesel Sales Corp.

◆

The appointment of **U. & S. Inc.**, Syracuse, N. Y., as sales representative for central and eastern New York State has been made by the **American Flexible Coupling Co.**, Erie, Pa.

◆

Expansion of facilities for a new shot peening division has been completed by **The Precision Shot Co.**, Birmingham, Mich. This division operates as a pilot and contract production shot peening shop, offering experimental facilities and consultation service.

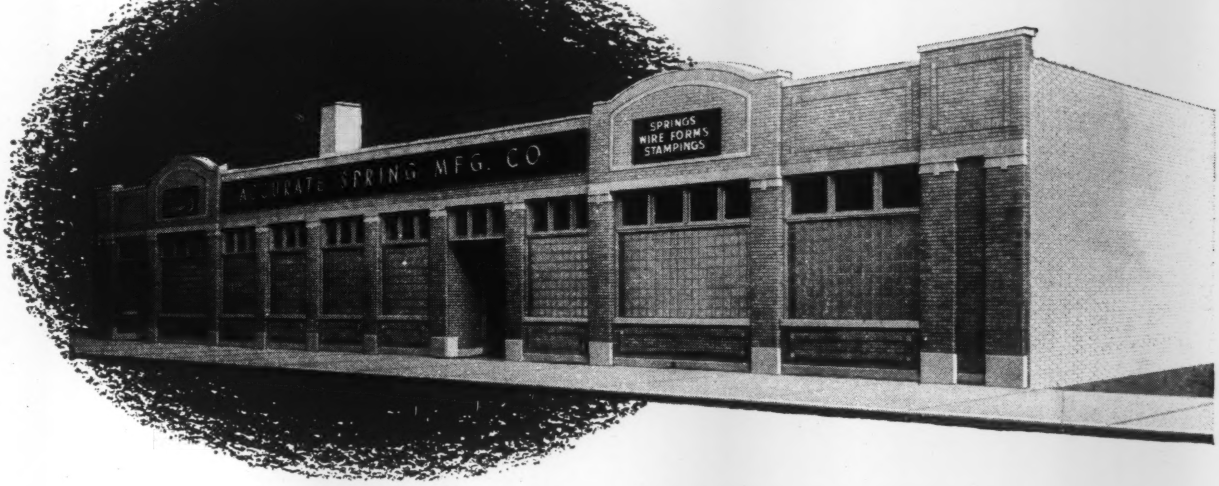
◆

A new sales and service branch has been opened at 2432 South Broadway, Los Angeles 7, Calif., by **The Black & Decker Mfg. Co.**, Towson, Md.

◆

Uniform Tubes, Collegeville, Pa., seamless tubing manufacturer, has appointed **Griswold and Co.**, 1329 Highland Ave., Needham 92, Mass., as exclusive representative for the territory covering the New England states, with the exception of Fairfield County, Conn.

There's a lot of spring know-how enclosed by these walls . . .



and it's ready to work for you in civilian or defense production

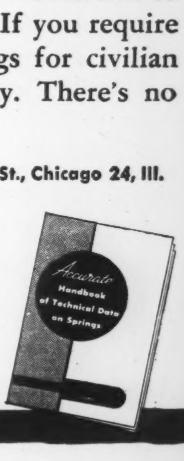
IN the manufacture of precision springs in large quantity, the intangible ingredient "know-how" is a mighty important factor. To the purchaser, it can mean very important savings not only in first cost but in the sum of all the costs involved in getting the spring into your product and ready to function.

We have many case histories to show you how tooling and methods developed by Accurate have made it possible to slash the cost of springs to our customers — and in most cases the customer got better, more accurate springs.

We'll be happy to show you what we have done for others but, most of all, we would like to show you what we can do for you. If you require large quantities of precision springs for civilian or defense production, write today. There's no obligation.

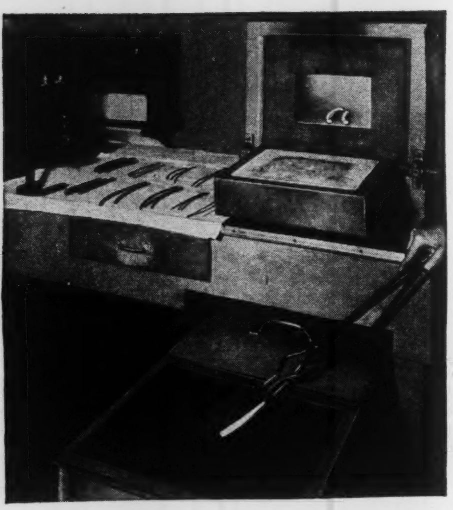
ACCURATE SPRING MFG. CO. 3813 W. Lake St., Chicago 24, Ill.

The Accurate Spring Handbook is a widely used guide for making spring calculations. You'll find it full of helpful short cuts. If you do not have a copy of this latest edition, write for yours, today.



Accurate Springs

SPRINGS • WIRE FORMS • STAMPINGS



Material Inspection

After visual and etch inspection all coils and bars of steel must pass a special heat treatment before they are acceptable for Universal Precision Balls.

In this laboratory test steel structure and heat treating properties are carefully checked. Possible surface decarburization and inclusions are also verified and kept within limits that insure the perfect finished product.

A machine load of 1/8" diameter balls represents 500,000 pieces—every one of which must be perfect in every detail. This necessitates steel that meets specifications 100%.

Whenever you need precison balls of extremely fine tolerances, perfect surface finish, sphericity and size accuracy—specify Universal Precision Balls. They reduce friction, wear and maintenance costs to an absolute minimum. All Universal Balls are 100% inspected and individually gauged.

UNIVERSAL BALL CO.

PRECISION BALLS OF CHROME
AND STAINLESS STEEL, BRONZE
AND SPECIAL METALS.

WILLOW GROVE, Montgomery County, Pa.
Telephone, Willow Grove 1200

Meetings

AND EXPOSITIONS

Feb. 10-18—

National Association of Aluminum Distributors. First annual meeting to be held at the Drake Hotel, Chicago, Ill. Raymond L. Collier, 905 Midland Bldg., Cleveland 15, O., is executive secretary.

Feb. 18-20—

American Management Association. Personnel conference to be held at the Palmer House, Chicago, Ill. Additional information may be obtained from society headquarters, 330 West 42nd St., New York 18, N. Y.

Feb. 18-21—

American Institute of Mining & Metallurgical Engineers. Annual meeting to be held at Hotel Statler, New York, N. Y. Edward H. Robie, 29 West 39th St., New York 18, N. Y., is secretary.

Feb. 22—

Malleable Founders' Society. Western sectional meeting to be held at the Drake Hotel, Chicago, Ill. Additional information may be obtained from society headquarters, 1800 Union Commerce Bldg., Cleveland, O.

Mar. 3-7—

American Society for Testing Materials. Spring meeting to be held at the Statler Hotel, Cleveland, O. Additional information may be obtained from society headquarters, 1916 Race St., Philadelphia 3, Pa.

Mar. 4-6—

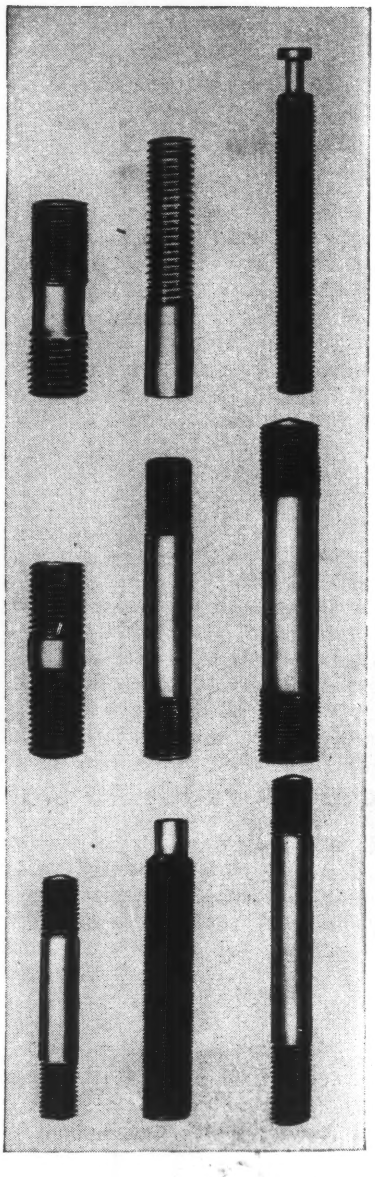
Society of Automotive Engineers. Passenger car, body and materials meeting to be held at the Book-Cadillac Hotel, Detroit, Mich. John A. C. Warner, 29 West 39th St., New York 18, N. Y., is secretary and general manager.

Mar. 7—

Malleable Founders' Society. Eastern sectional meeting to be held at the Commodore Hotel, New York, N. Y. Additional information may be obtained from society headquarters, 1800 Union Commerce Bldg., Cleveland, O.

Mar. 11-14—

Society of the Plastics Industry. Fifth national plastics exposition to be held at Convention Hall, Philadelphia, Pa. William T. Cruse, 67 West



WHEN IT'S Special BOLTS and STUDS

Send your Specifications to

ERIE

37 years' experience in making special bolts, studs, nuts for specific job requirements.

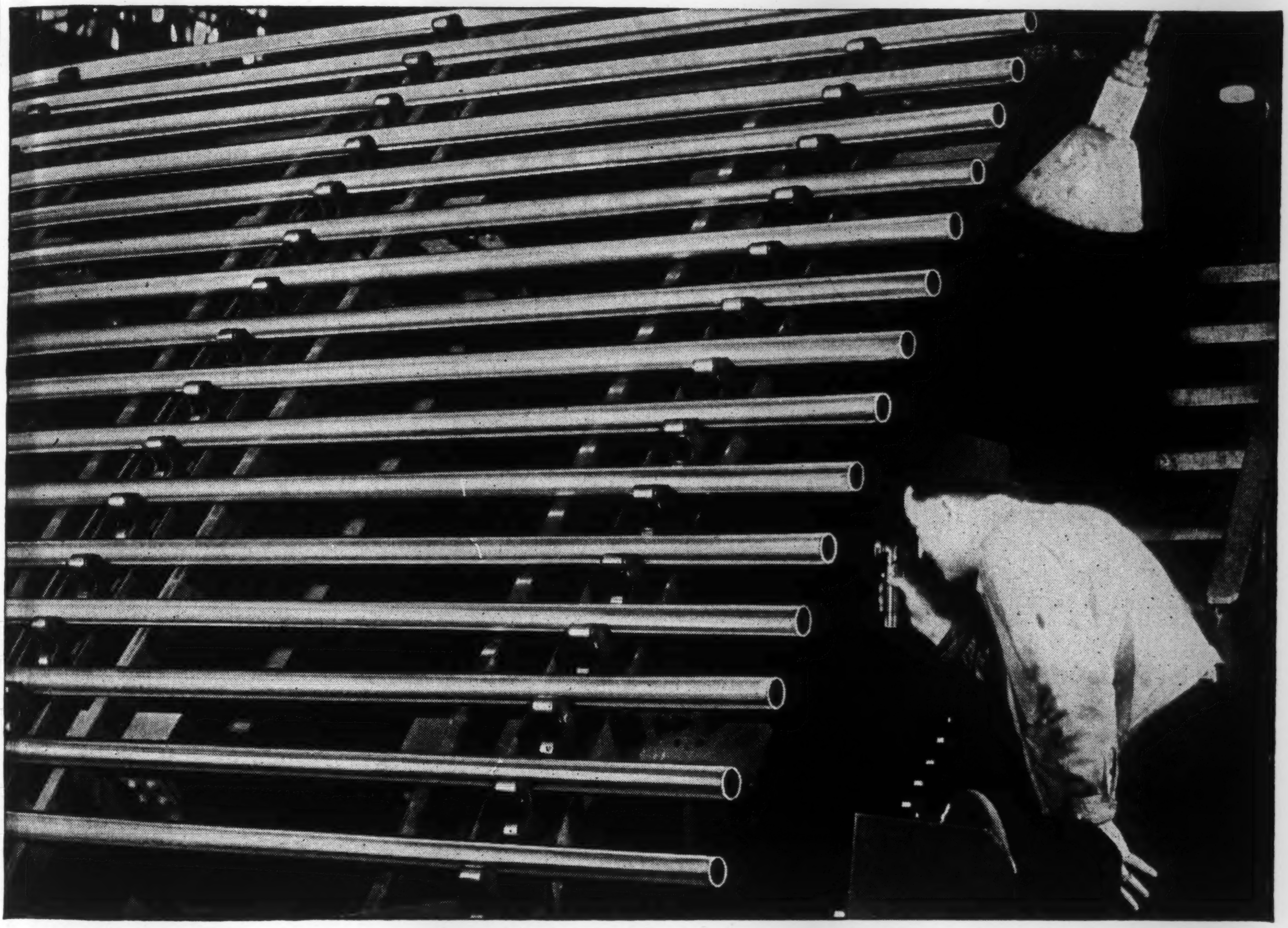
Send your blueprints to

ERIE BOLT & NUT CO.
ERIE · PA

A SUBSIDIARY OF
Barium
STEEL CORPORATION
Steelwright to the Nation

ALLOYS

REPRESENTATION IN PRINCIPAL CITIES



***SPECIALIZATION* GIVES YOU UNIFORM HIGH QUALITY IN**

GLOBE ALLOY STEEL TUBES

When you specify GLOBE you get the finest, because Globe *specializes* in the production of steel tubes. For more than thirty years Globe *specialized* research, engineering and manufacturing facilities have assured customers of uniform high quality in alloy steel tubes for pressure or mechanical applications.

GLOBE STEEL TUBES Co., Milwaukee 46, Wis.
Chicago • Cleveland • Detroit • New York • Philadelphia
St. Louis • Denver • San Francisco • Glendale, Cal.

Producers of Globe seamless stainless steel tubes — Gloweld welded stainless steel tubes — alloy — carbon — seamless steel tubes — Globeiron (high purity ingot iron) seamless tubes — Globe Welding Fittings.

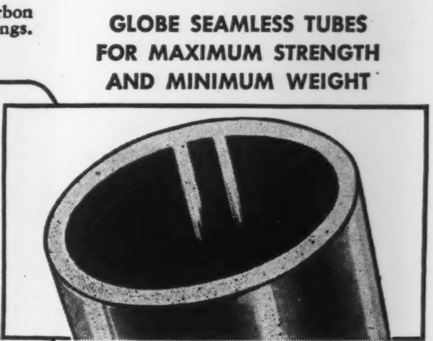
TYPICAL ANALYSES:

Carbon Moly.
1-1/4 Chrome 1/2 Moly • 1-3/4 Chrome 3/4 Moly
2 Chrome 1/2 Moly • 2-1/4 Chrome 1 Moly
5 Chrome 1/2 Moly • 7 Chrome 1/2 Moly
9 Chrome 1 Moly
A1S1 1335 • A1S1 2317 • A1S1 2512 •
A1S1 4130, 4140 • A1S1 4615 • A1S1 8615,
8620, 8630, 8635, 8640 • 7% Ni. • 9% Ni.

TYPICAL APPLICATIONS

Pressure Tubes — Superheater Tubes — Condenser Tubes — Still Tubes — Evaporator Tubes — Barrel Tubes — Oil-Well Pump Barrels — Mechanical Tubes — Aircraft Tubes—Rollers for Transmission Chains

GLOBE SEAMLESS TUBES FOR MAXIMUM STRENGTH AND MINIMUM WEIGHT



Pierced from solid steel billets . . . with no seams or welds, Globe seamless tubes are available in many sizes and wall thicknesses for exacting applications.

44th St., New York 18, N. Y., is executive vice president.

Mar. 17-19—

Midwestern Conference on Fluid Mechanics. Second conference to be held at Ohio State University. Columbus, O. Additional information may be obtained from Professor Geoffrey Keller, conference secretary.

Mar. 17-21—

American Society for Tool Engineers. Twentieth annual meeting and industrial exposition to be held at the International Amphitheatre in Chicago, Ill. Harry E. Conrad, 10700 Puritan Ave., Detroit 26, Mich., is executive secretary.

Mar. 18-19—

Steel Founders' Society. . Annual meeting to be held at the Edgewater Beach Hotel, Chicago, Ill. Additional information may be obtained from society headquarters, 920 Midland Bldg., Cleveland, O.

Mar. 22-Apr. 6—

International Trade Fair. Second trade fair to be held at the Navy Pier in Chicago, Ill. John N. Gage, Colonel, U. S. A. (Ret.) 10316 Merchandise Mart, Chicago 54, Ill., is executive vice president.

Mar. 24-26—

American Society of Mechanical Engineers. Spring meeting to be held at the University of Washington, Seattle, Wash. C. E. Davies, 29 West 59th St., New York, N. Y., is secretary.

Mar. 26-28—

American Power Conference, formerly Midwest Power Conference, sponsored by the Illinois Institute of Technology to be held at the Sherman Hotel, Chicago, Ill. Additional information may be obtained from Dr. R. A. Budenholzer, Director of the Conference, 3300 Federal St., Chicago 16, Ill.

Mar. 30-31—

Packaging Machinery Manufacturers Institute. Semiannual meeting to be held at the Hotel Dennis, Atlantic City, N. J. Additional information may be obtained from society headquarters, 342 Madison Ave., New York 17, N. Y.

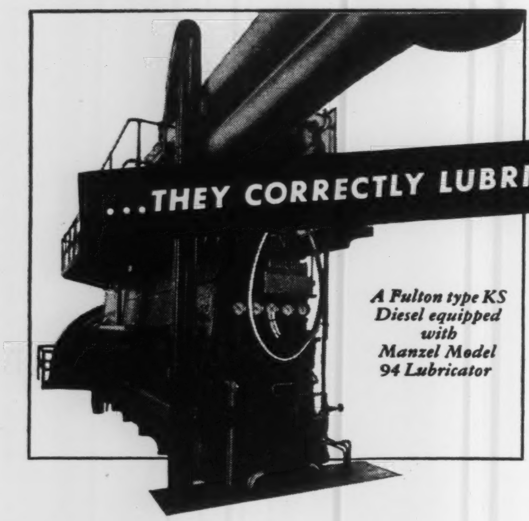
Apr. 1-4—

American Management Association. The 21st national packaging exposition to be held in the Atlantic City Auditorium, Atlantic City, N. J. Additional information may be obtained from society headquarters, 330 West 42nd St., New York 18, N. Y.

LEADING DIESEL ENGINES HAVE *Manzel*

FORCE FEED LUBRICATORS

...THEY CORRECTLY LUBRICATE EACH POINT


A Fulton type KS Diesel equipped with Manzel Model 94 Lubricator

Manzel Lubricators supply the *exact* amount of oil needed at each wearing point, reducing oil consumption as much as 90%.

They are furnished as standard equipment on leading makes of engines, and machinery. Or they can be installed on your present equipment.

We will gladly have a Manzel lubricator engineer submit recommendations without obligation. Just write...

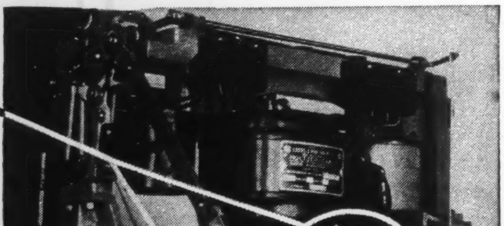
Why it Pays to Select Manzel Lubricators

- THEY LENGTHEN THE LIFE OF MACHINERY
- THEY ARE AUTOMATIC AND TROUBLE-FREE
- THEY ELIMINATE "DOWN TIME"
- THEY CUT OIL CONSUMPTION UP TO 90%

Manzel 276 BABCOCK STREET
BUFFALO, NEW YORK

Mass. Gear

Applied in Recording Instruments

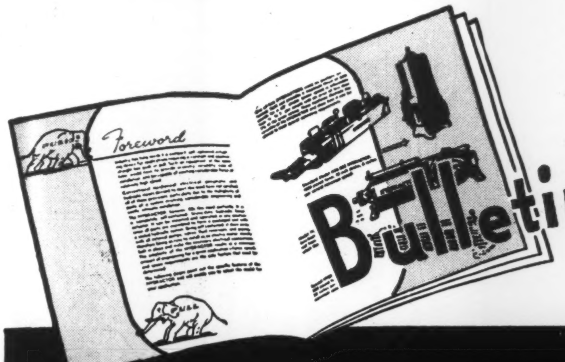


Leeds & Northrup Co., manufacturers of electrical measuring and recording instruments, automatic controls and heat-treating furnaces, have been using gears made by Massachusetts Gear & Tool Co. for over a quarter of a century.

The illustration shows typical use of "Mass Gears" in Leeds & Northrup's Speedomax Pyrometers.

If you have a gear problem, let "Mass Gear" help you. Write for free catalog to Massachusetts Gear & Tool Co., Woburn, Mass.

Massachusetts Gear & Tool Co.
Woburn, Mass.

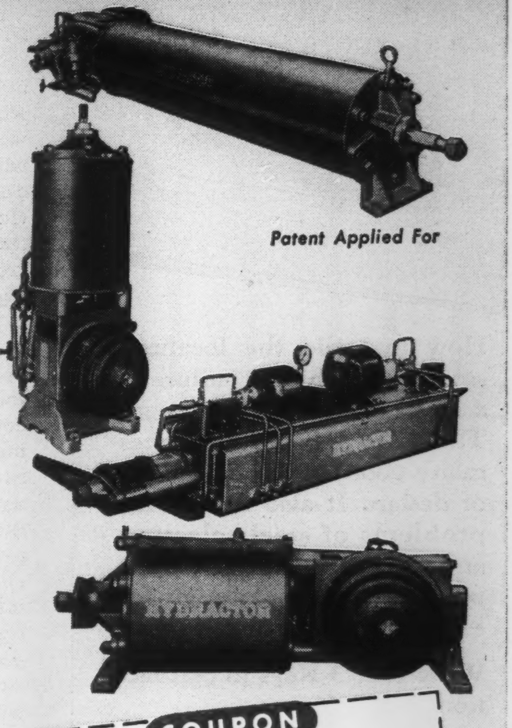


Bulletin 551 shows WHY

THERE IS A DEFINITE NEED IN INDUSTRY FOR

Lassman HYDRACTORS

A COMPLETELY PACKAGED HYDRAULIC UNIT



Patent Applied For

The reason for preparing our 10-page BULLETIN 551 is because we wanted to introduce to you what we feel to be new and unique in the line of packaged hydraulic power units.

Every passing year since 1921 . . . when we started to specialize in the engineering and manufacturing of Hydraulic Equipment . . . we felt more and more that there was a definite need for a compact, self-contained, hydraulically powered actuating device for applications requiring a constant and positive straight line push or pull.

We realized that such a device would have to provide economy, versatility, ease of installation and be capable of exerting considerable force at relatively high speed.

The result of our thinking, planning, experimenting and successful engineering is a completely packaged Hydraulic Unit . . . The Hydractor.

We believe you will find BULLETIN 551 interesting and informative. We would like to send you a copy with the hope that after reading it you will see where the Hydractor is advantageously suited to your application.

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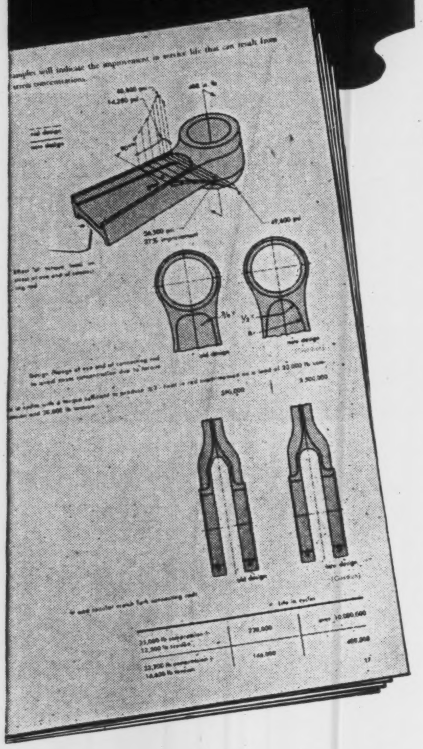

How to avoid the localized stresses which start failure is a basic problem of design. This 72 page booklet analyzes many good and bad features of design. It also deals with problems of steel selection and treatment from the viewpoint of the design engineer—instead of the metallurgist.

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New Machines

Domestic

REFRIGERATORS: Twelve models range from 7 to 12 cu ft capacity. Two models feature flash defrosting, accomplished in from 7 to 10 minutes; one has fully automatic defrosting. Two-door Dual-Temp unit holds 77 lb of frozen foods in separate freezer compartment and in freezer door shelf. *Admiral Corp., Galesburg, Ill.*

ELECTRIC RANGES: Three new models all accommodate Admiral's self-basting rotary roaster spit; have extra-high-speed surface unit. New type interval timer can be set for 30 seconds to 15 minutes in ¼-minute intervals and for 15 to 90 minutes in 2½-minute intervals. Frame and chassis of all steel welded type construction. Tops finished in acid-resistant titanium porcelain enamel. *Admiral Corp., Galesburg, Ill.*

REFRIGERATORS: Nine models range from 4 cu ft under-counter units to combination types with 10.6 cu ft capacity. Deluxe combination models have eight different food preservation zones, including frozen food section, fresh food storage, door shelves, butter conditioner, high humidity storage, left-over rack with covered jars, tall bottle zone, and meat storage. "Super-Stor" models with door shelves available in both combination and single-door types. All have automatic door latch that pulls door tightly shut. *Hotpoint Inc., Chicago, Ill.*

HOME FREEZER: Eleven cu ft model with 385 lb capacity is one ft narrower than former models. Freezing unit located beneath cabinet. Equipped with storage baskets, automatic temperature control, interior light, alarm signal light and vacuum sealed freezing unit. Fifteen and 23 cu ft models also available. *Hotpoint Inc., Chicago, Ill.*

FOOD WASTE DISPOSALS: In standard and pre-plumbed models with combination drain safety lock, sink stopper and nonclogging mechanism. Hard steel shredders may be controlled to rotate in either direction to prevent clogging and increase life of working parts. *Hotpoint Inc., Chicago, Ill.*

ELECTRIC CLOTHES DRYER: Has 60-minute cycle for ordinary drying

ARTIST • AMADO GONZALEZ

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Most forms of magnesium are weldable. While joint strengths will vary with different alloys, typical properties of welded butt joints show tensile strengths up to 42,000 psi. and elongation up to 12%. In addition, magnesium welds are comprised of dense metal and are substantially free of microporosity.

The combination of relatively high weld strength and minimum specific gravity found in magnesium generally permits the design of welded magnesium structures that are lighter, stronger, and more rigid than is possible in other light metals. Dow has over 30 years of experience in the production and fabrication of magnesium—a call to your nearest Dow sales office will put this knowledge at your disposal.

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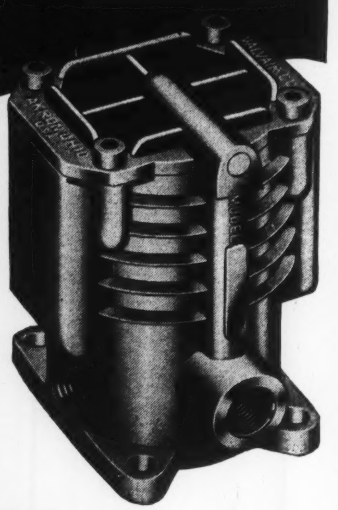
PILOT VALVE



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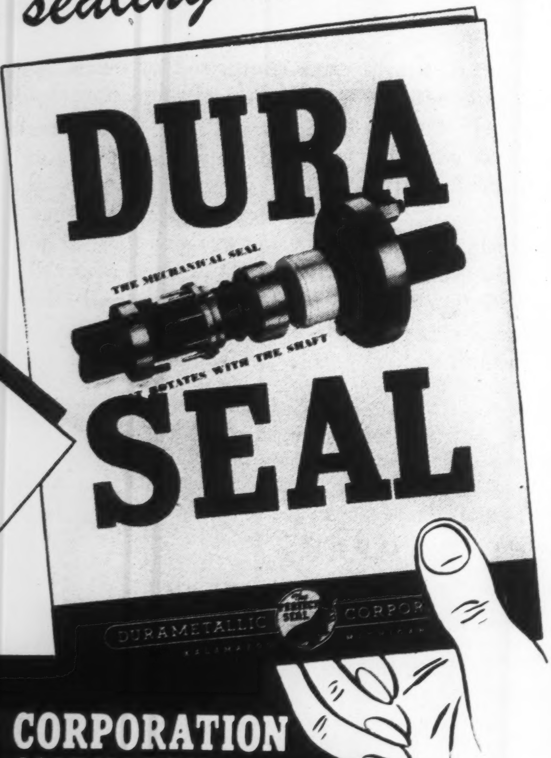

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loads and an additional 30 minutes for clothes washed in wringer-type machines. Sealed-in dryer eliminates discharge of steam and lint into laundry room. Employs fine spray of cold water to condense moisture from heated air inside machine. Moisture and lint are discharged through drain hose. *Hotpoint Inc., Chicago, Ill.*

AUTOMATIC WASHING MACHINE: Has single-control dial. User selects quantity and temperature of water. Unit loads from the top; has agitator type washing action. Spin dryer mechanism equipped with automatic fluid drive to prevent vibration. Washing time as set by dial varies from 19½ to 30½ minutes. *Hotpoint Inc., Chicago, Ill.*

Heating and Ventilating

PORTABLE HEATING MACHINE: Model PW-140, 140,000 Btu unit for indoor or outdoor use. Blows warm air out of base to create heat blanket. Burns regular furnace type fuel oil of No. 3 or lighter grades, or kerosene; requires no flue or chimney. Has 6-gal fuel tank attached. Size: 21 by 33 by 58 in. high; weighs 245 lb. *Fageol Heat Machine Co., Detroit, Mich.*

HOME AIR CONDITIONERS: Have hermetically sealed and spring-mounted compressors. Model 33, with ⅓-hp motor, has capacity of 4200 Btu per hr for rooms up to 230 sq ft; air-discharge velocity of 470 fpm. Can remove 1.3 pints of air moisture per hr. Size: 13½ by $23\frac{1}{16}$ by 27 in.; weighs 120 lb. Model 50, ½-hp, has capacity of 6100 Btu per hr for rooms up to 325 sq ft; air-discharge velocity of 560 fpm. Can remove 1.75 pints of air moisture per hr.; $13\frac{3}{16}$ by 27 by 27 in.; 176 lb. Model 75, ¾-hp, has capacity of 8100 Btu per hr for rooms up to 485 sq ft; air-discharge velocity rate adjustable from 510 to 700 fpm. Can remove 2.5 pints of air moisture per hr; $15\frac{3}{16}$ by 27 by 27 in.; 198 lb. *RCA Victor Division, Radio Corp. of America, Camden, N. J.*

Materials Handling

MANUAL DRUM UP-ENDER: Consists of two shoes which slip over the forks of any standard fork truck. Rubber-faced grab plates welded to shoes clamp around drum to hold it firmly. An arm on each shoe supports the handle used to up-end drums for emptying. Drums are carried vertically and can be tilted forward to a horizontal position for stacking or 45 degrees below horizontal for emptying. Drums can be emptied safely from any height

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within arm reach of operator. *Baker Industrial Truck Division of The Baker-Raulang Co., Cleveland, O.*

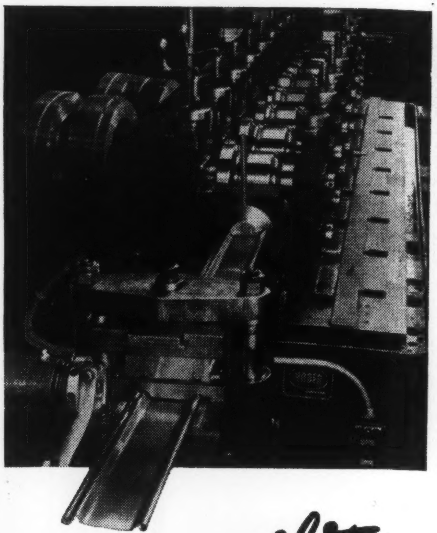
HAND LIFT PALLET TRUCK: Available with dual-purpose superstructure that makes possible the handling of 7 and 12-in. skids as well as single or double-faced pallets. When superstructure is in raised position it is clamped vertically to provide a backrest for the pallet load on truck. When lowered, it is adjustable to either 7 or 12 in. skid heights by a cam and slot arrangement. Available in either mechanical or hydraulic lifts. *Philadelphia Division, The Yale & Towne Mfg. Co., Philadelphia, Pa.*

ELECTRIC TRACTOR: Heavy-duty unit powered by two high-capacity series-wound enclosed motors capable of delivering 800 lb normal and 5500 lb maximum drawbar pull. Four-wheel drive, four-wheel steer unit controlled by steering wheel and accelerator pedal. Has four speeds in either direction. Drive axle assemblies consist of double-reduction, spiral bevel and spur gear units with standard four-pinion differential. Drive shafts are full-floating and wheels are Timken-bearing mounted. *The Mercury Mfg. Co., Chicago, Ill.*

MOBILE CRANE: Electric powered unit redesigned with wider bed and higher operator control pedals for better forward visibility. Powered by either electric storage battery or gas-electric unit. Capacity is 10,000 lb at 5½-ft radius. With boom fully extended to 19 ft, hook height of 18 ft can be obtained. Overall length and width, 130⅝ and 66¾ in. Turns in 95-in. intersecting aisles. Maximum slue, 296 degrees. Features four-wheel steering, telescoping boom to provide boom lengths from 12 to 19 ft, three individual motors with solenoid operated brakes for powering slue, hoist and boom. *The Elwell-Parker Electric Co., Cleveland, O.*

DRUM-HANDLING ATTACHMENTS: For use with Hyster Load Grab attachment. Features steel-backed replaceable rubber pads. Rubber has both mechanical anchor and vulcanized bond to the steel backing. Six bolts attach each pad to arm. Standard Model 20 lift truck equipped with two-drum arm has average rated load of 1990 lb. With four-drum arm, Model 40 has average rated load of 2800 lb. *Hyster Co., Portland, Ore.*

FORK LIFT TRUCKS: Twelve models powered with either diesel or gasoline engines, solid or cushion tires, in capacities of 3000, 4000, 5000, 6000 and 7500 lb at a 24-in. load



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of COLD-ROLL FORMING

● In metal fabrication, new applications are constantly being discovered for doing by cold-roll-forming what has heretofore been done by other methods, at higher cost.

Where quantity requirements initially are too small, the advantages of cold-roll-forming may be overlooked until long after increased demand has made this method more economical.

Then there are many instances in which cold-roll-forming is erroneously assumed to be impractical because other operations are involved, such as perforating, embossing, welding, curving, coiling, ring forming, filling, etc.

As a matter of fact, the majority of roll-forming applications are individually engineered, with or without accessory attachments or tooling, for just such operations.

If you suspect the existence of applications of this nature in your plant, feel free to call on Yoder engineers for a survey or analysis, followed by recommendations as to the practicability and cost of employing roll-forming to advantage.

Roll-Forming Book on request.

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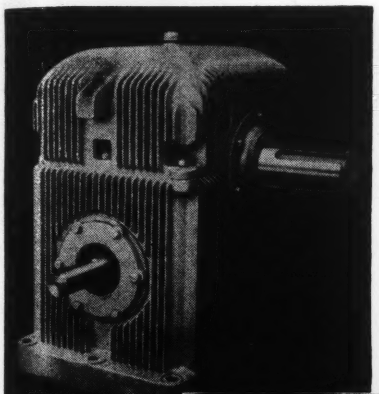
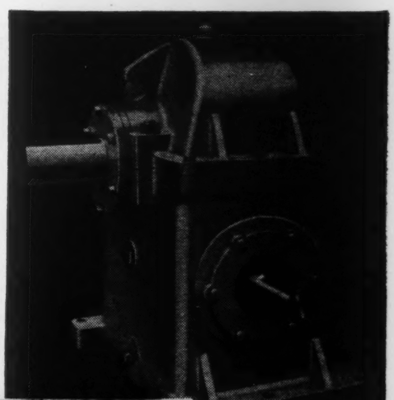
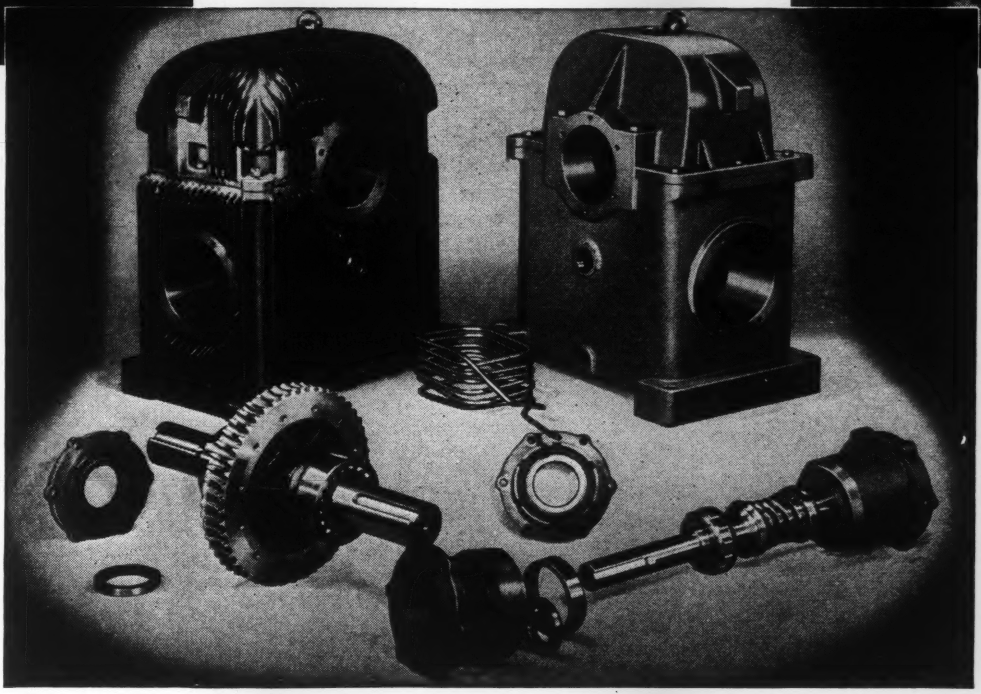
Cold-Roll FORMING MACHINES



Shown here are two reducers—a STANDARD, at left, a SPECIAL at right. Yet, except for the housing, parts are completely interchangeable.





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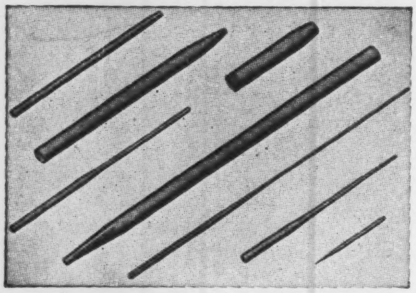

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DETACHABLE RAM: For handling coiled wire. Quickly installed or detached from truck carriage. In picking up ram, truck is moved into position at rear of ram and carriage is raised so cradle arms on carriage engage a mounting spool on back plate of ram. To detach ram, operator positions it on supports and disengages cradle and spool by lowering truck carriage. Used to transport coils of steel wire from storage to feeders. Ram is placed in feeder, detached from truck and stays in feeder while wire is run off to wire drawing machine. *Baker Industrial Truck Division of The Baker-Raulang Co., Cleveland, O.*

ELECTRIC TRACTOR: Medium-duty two-wheel drive machine rated at 400 lb normal and 2000 lb maximum drawbar pull. Attains light running speed of 7½ mph when powered by 48-v source specified. Tiller bar controls four-wheel steering system. Standard speed control arrangement is by manually operated three-speed snap-action mechanical contactor unit; foot operated control also available. Has cushion tires, semi-elliptic spring suspension, front and rear; and a unit-constructed, double-reduction spiral bevel and spur geared power plant. *The Mercury Mfg. Co., Chicago, Ill.*

Metalworking

TANGENT BENDER: Single-wing unit shapes flanged sheets around radiused corner dies without wrinkling. For forming metal cabinets, cases, housings, liners, etc. Features automatic positioning and open-throat design which permits removal of fully formed shapes easily and quickly. Ram latches with bed in last inch of travel and exerts up to 17 tons vertical pressure. Metal blank is positioned on bed of machine containing female die. Overhead arm or ram, holding male die, clamps material in position. Forming wing swings out and upward to effect positive shaping. At the same time slitting, piercing, stamping or cutting operations can be performed. Avail-

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GAST PUMP
MOTOR
SHOWN WITH COVER REMOVED

PROBLEM: Place cap on milk bottle at the right instant — when, and *only* when, bottle is ready.

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RESULT: Dependable operation, moderate cost for pump, long-term satisfaction.

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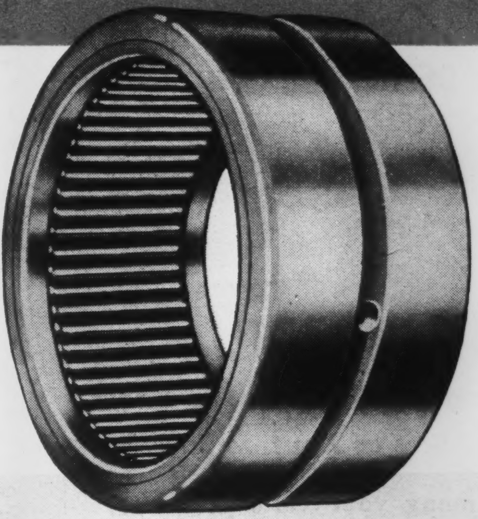

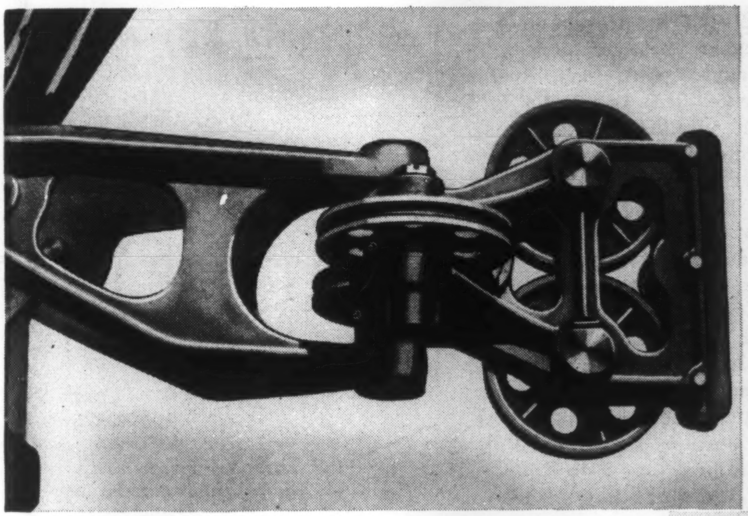

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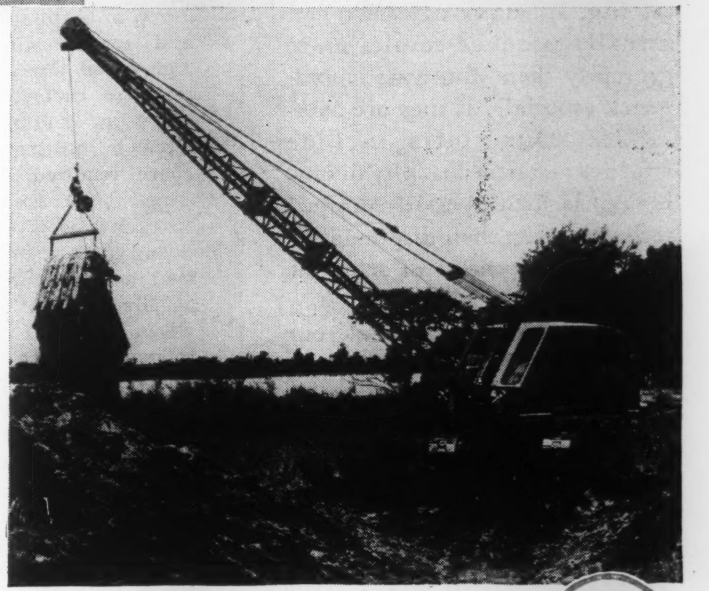
Orange Roller Bushings are compact, precision bearings, equally adapted to rugged installations or the most exacting requirements for even, smooth, quiet running. Dimensions are rigidly standardized, to provide closer internal running clearances, minimizing possibility of misalignment of rollers. Rollers and raceways are made of finest bearing steel—raceways are through-ground — exceptional standards of hardening, finishing and assembly are enforced.



- ***Write for Engineering Data Book showing design, sizes, capacities, installation data, etc.***

ORANGE

ORANGE ROLLER BEARING CO., Inc. 556 Main St., Orange, N. J.

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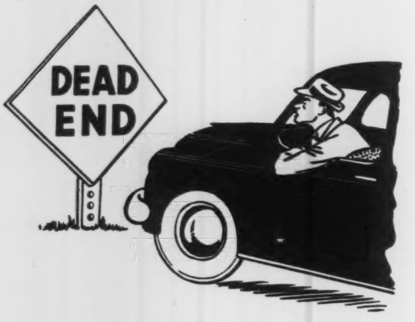
IS SCARCE!



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able in three types having die space of 24, 36 or 48 in. Can be furnished for air or hydraulic operation with control for completely automatic cycling or with separate ram and wing controls for manual operation. *The Cyril Bath Co., Cleveland, O.*

LATHE: Cam-operated rear cross slide offers increased rigidity for forming, grooving, necking and similar operations. Cam feeds slide into workpiece, moving slide inward at a constant rate. When tools reach end of stroke, inward feed ends in cam slot. Rack and pinion cross slide can be furnished. *Lodge & Shipley Co., Cincinnati, O.*

QUENCHING PRESS: For armor plate production; handles large plates from ½ to 2 in. thick. Overall bed size, 72 by 235 in.; clearance between rod shields, 98 by 72 in. Hot armor plate from hardening furnace is placed in press and held under pressure between dies while being sprayed with cold water. Process takes less than two minutes and eliminates subsequent straightening operations. *The Hydraulic Press Mfg. Co., Mount Gilead, O.*

TRANSFER MACHINE: For processing the intake manifold of V-type engine block. Drills, taps, reams and spotfaces all holes and mills the carburetor and water outlet pad. Capacity is 72 pieces per hour at 80 per cent efficiency. Workpiece is hydraulically located and clamped at each station and moved between stations by hydraulically-operated transfer bar. Fixtures move on V-type rails with hardened and ground surfaces. Tools are high-speed steel, and milling cutters are carbide. Tool speeds: 80 sfpm in drilling operations, 250 sfpm in milling operations. Floor space required, 10 by 40 ft. *Snyder Tool & Engineering Co., Detroit, Mich.*

SOLDERING-BRAZING GUN: Deposits lead and tin-base solders, as well as silver solder and other brazing wires, in liquid or semiliquid form to parts moving at constant speed under gun nozzle. Soldering or brazing can be either intermittent or continuous at any desired rate of speed. up to 200 fpm. *Metallizing Co. of America, Chicago, Ill.*

PROFILER-MILLING MACHINE: Redesigned with improved spindle bearings. Shafts are splined instead of using keyways, including the cutter spindle. Features hardened and ground steel cross-slide ways; travel-head is now mounted on ball bearing rollers. For economical duplication of small parts requiring accurate interchangeability — air-

TAP-LOK
INSERTS

strengthen
power tools--
Chain Saws,
for instance

THIS magnesium die cast housing is part of the Chain Saw manufactured by Homelite Corporation. Such tools must be strong in every part, to withstand rigorous use.

To strengthen the tapped threads indicated by arrows, Homelite uses Tap-Lok Inserts. They report that the Insert not only provides a dependable nonstripping fastening, but also acts as a lock on the screw, preventing it from vibrating loose during use.

The unique self-tapping feature of this hardened steel bushing also substantially reduces assembly costs by eliminating a separate tapping operation.

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Any speed you select at your finger-tips (40:1 range available).
A. C. POWER INPUT
The speed you need, here . . . Once selected, the motor speed remains constant—regardless of load.
D. C. DRIVE MOTOR
Any rating up to 150 H.P.
All types of enclosures.

THE MAGNETIC AMPLIFIER

— HEART OF THE SELECT-A-SPEDE

The Magnetic Amplifier, a self-saturating reactor, like a transformer, contains no moving parts — no parts requiring maintenance or periodic replacement. Its function in the Select-A-Spede, is to constantly regulate the field currents of both motor and generator. It requires no "warm up" period, has an extremely fast response to changing conditions, and is completely reliable at all times.

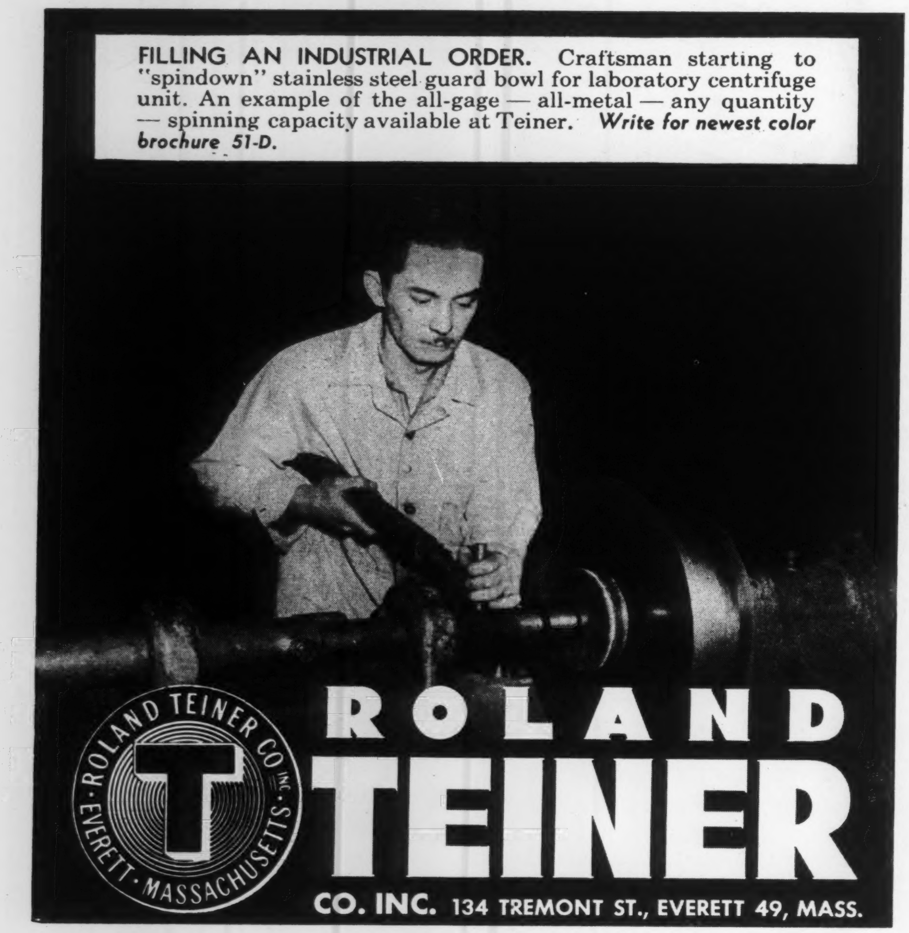
For economical "on the spot" conversion of AC power for an adjustable speed drive (even better than a DC motor supplied from a constant voltage power supply) — the Louis Allis Select-A-Spede is unsurpassed. It is the only AC adjustable speed drive offering the advantage of the new magnetic amplifier control — with close speed regulation at all rated speeds and loads.

The Select-A-Spede also offers a variety of optional features, such as: reversing, dynamic braking, jogging, sequence control, controlled acceleration, interlocked slow speed start, multi-motor drives, etc. It is possible to provide a Select-A-Spede Drive to exactly suit your special requirements.

For further information, contact your nearest Louis Allis Application Engineer or write for Bulletin 1100-B.

LOUIS ALLIS

THE LOUIS ALLIS CO., MILWAUKEE 7, WIS.


FILLING AN INDUSTRIAL ORDER. Craftsman starting to "spindown" stainless steel guard bowl for laboratory centrifuge unit. An example of the all-gage — all-metal — any quantity — spinning capacity available at Teiner. *Write for newest color brochure 51-D.*

ROLAND TEINER CO. INC. EVERETT · MASSACHUSETTS

ROLAND TEINER

CO. INC. 134 TREMONT ST., EVERETT 49, MASS.

VIKING IN ROTARY PUMPS Has the Answer to Your Needs

LOW or HIGH CAPACITY

LIGHT or HEAVY LIQUIDS

HOT or COLD FLUIDS

CORROSIVE MATERIALS

ODD or STANDARD Drive Arrangements

PECULIAR Mounting Conditions

Whatever your pumping needs may be, start solving them today by requesting folder 52SH.

VIKING AN HONORED NAME IN PUMPING

Viking PUMP COMPANY CEDAR FALLS, IOWA

See Our Catalog In SWEETS

craft and gun parts, etc. *Morey Machine Co. Inc., New York, N. Y.*

PUNCH PRESS: Open back machine can be tilted to a maximum of 25 deg. Flywheel is at rear for safety of operator. Capacity, 5 tons; rated at 275 strokes per minute. Equipped with positive nonrepeat clutch which can be released for automatic feed. Throat depth, 6 in.; height of throat, 7 in.; length of stroke, 1 in. with stroke adjustment 1¼ in.; die space, 5¾ in. with stroke down and adjustment up. Size: 59 in. high; 22 in. wide at base; 28 in. deep. Bench model also available. *Whitney Metal Tool Co., Rockford, Ill.*

HOSE COUPLING MACHINE: Hydraulically operated unit does complete assembly and swaging job. Operator can make up finished hose, couplings at both ends, in four minutes. Cutting wheel cuts hose to length; wire wheel attachment skives each end of hose. Operator assembles sleeve on hose end, inserts coupling with power spinner, and places coupling in press which swages it permanently in one pass through dies. Stem of fitting is so designed that the hose wall is converted during swaging into a series of chevron formations resulting in an effective seal. Machine is equipped for operation on 115-v, 60-cycle current. *Pyles Industries Inc., Detroit, Mich.*

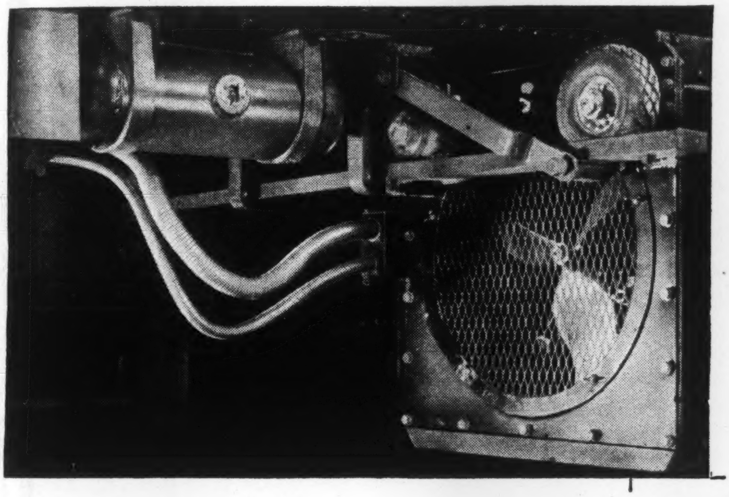
ROTARY STRAIGHTENER: For removing waves, bends and kinks from cut lengths of $\frac{1}{16}$-in. rod or up to ¼-in. OD thin wall tubing. Has three sets of identically contoured twin cross rolls, all power driven. Middle pair of rolls may be adjusted up or down so that correct amount of offset for good straightening effect is maintained between horizontal middle roll pass and horizontal entry and delivery roll passes. Straightening is accomplished by passing cut lengths of stock spirally through the three sets of cross rolls. Rolls are driven by 1/6-hp motors; operating speed is 100 fpm. Size: 22 in. wide, 19 in. deep, 8 in. high. *Mackintosh-Hemphill Co., Pittsburgh, Pa.*

GEAR HOBBER: Model No. 1 features two improvements: a vernier scale to establish turntable positions in minutes, and a knurled thumb wheel for positioning the hob relative to the workpiece. *The Hamilton Tool Co., Hamilton, O.*

Packaging

HEAT SEALER: For manufacture and final closure of large bags, pouches, envelopes, barriers, etc., made of kraft and scrim-backed laminates,

would a **flexible** connector help your product *"move"*?



squirts around corners

American asbestos-packed Flexible Bronze Tubing makes a flexible spout for this pistol type oiler made by the Plews Oiler Co.

rides the rods

These flexible refrigerant lines of American Seamless Bronze Tubing with a bronze protective casing permit this Waukesha Motor Co. railroad car air-conditioning unit to be rolled out for servicing and inspection. Pressure-tight and rugged, American Flexible Metal Connectors stand up under tough working conditions.

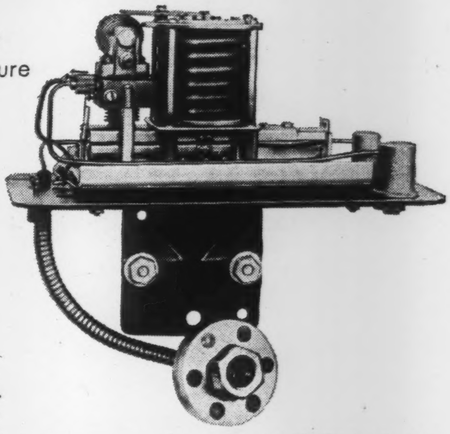
a flexible suggestion

in engineering your product: there's an American Flexible Metal Connector for every connector problem — for eliminating vibration, for cramped connections, for misaligned ports, for moving parts. Strong, tight and corrosion-resistant.

Write for Bulletins SS-50 and CC-300 to The American Brass Company, American Metal Hose Branch, Waterbury 20, Connecticut. In Canada: The Canadian Fairbanks-Morse Co., Ltd. Distributors in all key cities.

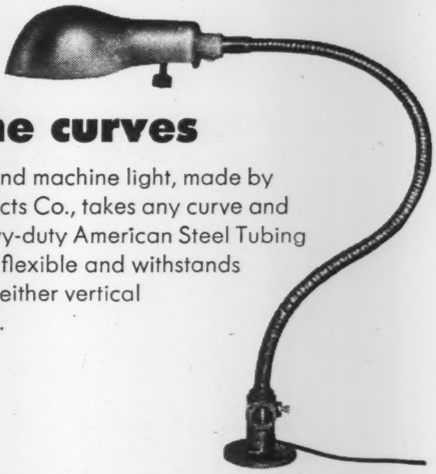
51236

modern coat of armor



This Taylor Instrument Co. "Transaire" Pressure Transmitter uses $^3/_{16}$ in. I.D. American Stainless Steel Tubing as a protective casing for the delicate capillary tubing connecting the volumetric pressure element with the instrument mechanism.

holds the curves



This Porta-Flex bench and machine light, made by Detroit Industrial Products Co., takes any curve and holds it. Its special heavy-duty American Steel Tubing remains both tight and flexible and withstands vibration. Base permits either vertical or horizontal mounting.

ANACONDA

from mine to consumer

wherever connectors must move . . .

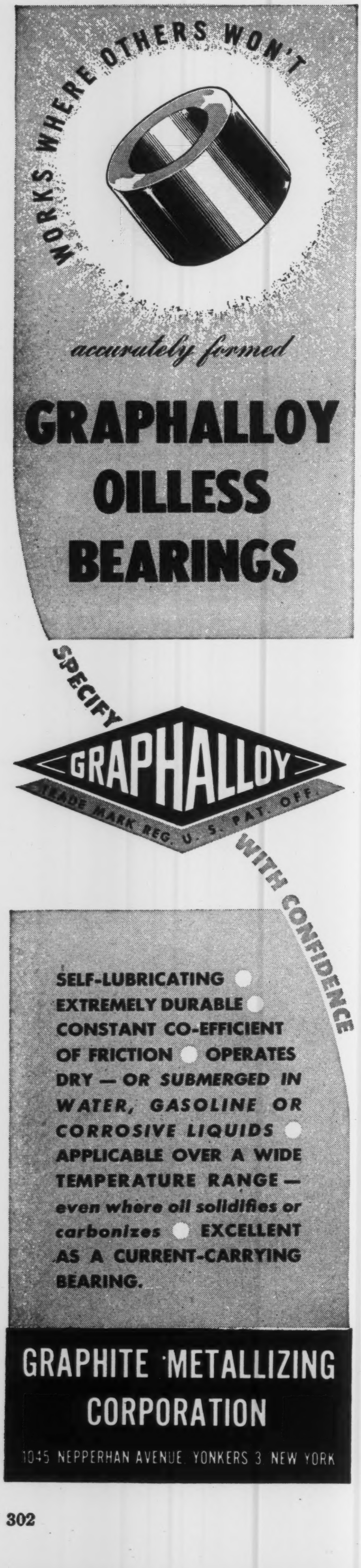
American **FLEXIBLE METAL HOSE AND TUBING**

cellophane, pliofilm, foil and similar heat-sealing materials. Sealing bars 38 in. long seal 36-in. standard width material. Movable sealing jaw is operated by air cylinder arranged with air regulator valve. Sealing pressures from 19 to 31½ psi over entire bar length are possible. Operates on 60 to 100 lb air pressure. Electric timer provided; time of dwell variable up to 30 seconds. Each bar has two brass-sheathed 375-watt heating elements. Temperature of sealing bars is thermostatically controlled over range of 0 to 550 F. Operated by electric foot switch. *Pack-Rite Machines, Milwaukee, Wis.*

Testing and Inspection

PRESSURE TRANSMITTER: For measuring vacuum pressures with reference to an absolute pressure. Consists of two opposing bellows connected to a cantilever beam spring and a differential transformer. Transformer requires as little as 1/100 gram for displacement of its armature for providing an ac output signal linear to within 0.1 per cent. One bellows is connected to the system to be measured while the other is the absolute pressure reference. Available in five standard ranges between 0-50 mm of mercury to 0-30 in. of mercury. Factory calibrated for accuracy with 0.50 per cent of full range. *Automatic Temperature Control Co. Inc., Philadelphia, Pa.*

OPTICAL DIVIDING HEAD: For checking angular dimensions such as the spacing of spur gear and ratchet teeth, for measuring eccentricity and contours of cams and other shapes, accuracy of milling cutters, broaches, splined shafts, etc., and for use on machine tools requiring precise positioning in either horizontal or vertical plane. Measurements are made optically by alignment of visible scales. Any one of a series of measurements is reproducible regardless of direction of spindle rotation. Optical system consists of a circular dial marked in 30-second divisions and an illuminated glass scale etched with degree marks from 0 to 360. Degree marks are projected onto ground glass screen and aligned between two reference marks on screen. Readings are taken at normal eye level; measurements are read directly on a large scale. Etched scale on spindle drum is sighted directly against degree reference marks in viewing glass. Angular dimensions specified are read directly on the optical system scales. *F. T. Griswold Mfg. Co., Wayne, Pa.*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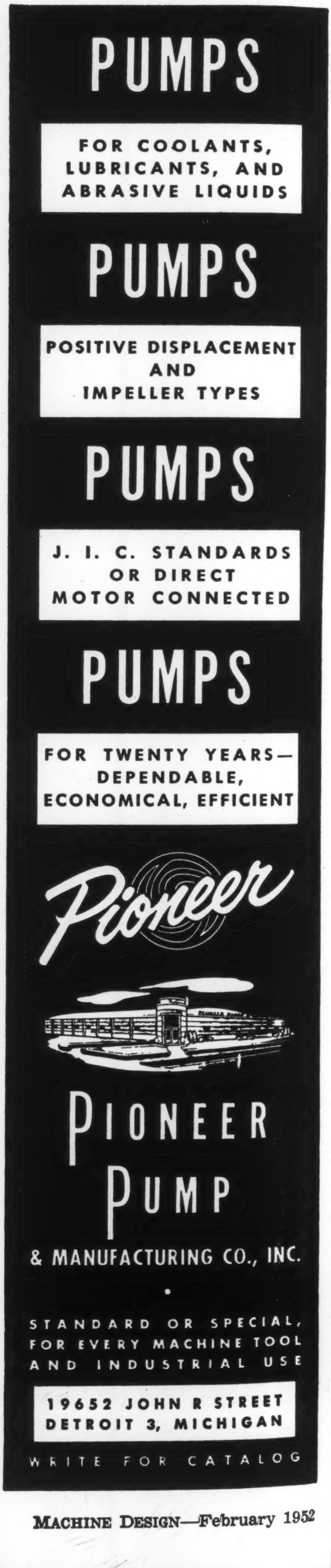
accurately formed
GRAPHALLOY OILLESS BEARINGS
SPECIFY
GRAPHALLOY
TRADE MARK REG. U. S. PAT. OFF.
WITH CONFIDENCE
SELF-LUBRICATING ● EXTREMELY DURABLE ● CONSTANT CO-EFFICIENT OF FRICTION ● OPERATES DRY — OR SUBMERGED IN WATER, GASOLINE OR CORROSIVE LIQUIDS ● APPLICABLE OVER A WIDE TEMPERATURE RANGE — even where oil solidifies or carbonizes ● EXCELLENT AS A CURRENT-CARRYING BEARING.
GRAPHITE METALLIZING CORPORATION
1045 NEPPERHAN AVENUE, YONKERS 3, NEW YORK


PUMPS
FOR COOLANTS, LUBRICANTS, AND ABRASIVE LIQUIDS
PUMPS
POSITIVE DISPLACEMENT AND IMPELLER TYPES
PUMPS
J. I. C. STANDARDS OR DIRECT MOTOR CONNECTED
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FOR TWENTY YEARS— DEPENDABLE, ECONOMICAL, EFFICIENT
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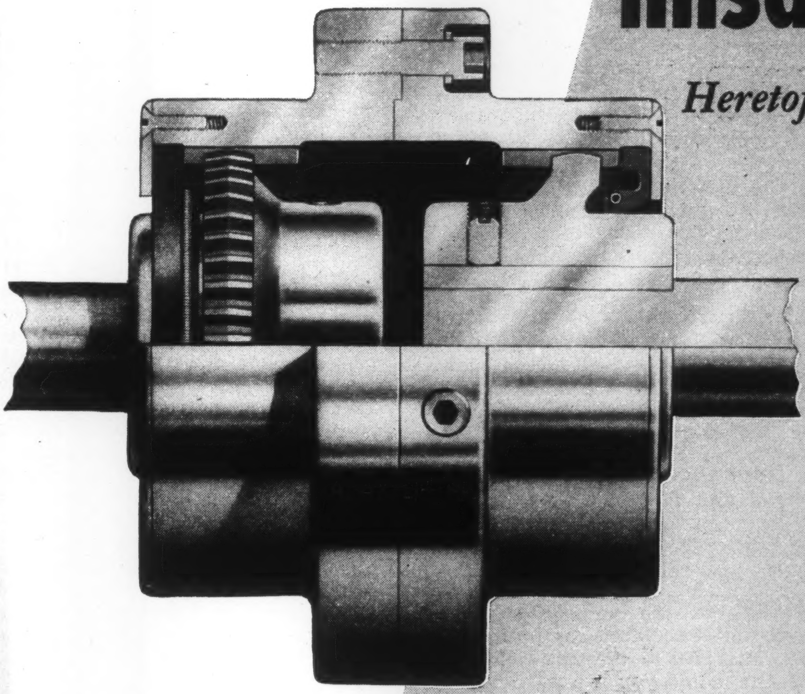
AJAX DIHEDRAL

FLEXIBLE COUPLINGS

provide for AND protect against misalignment

Heretofore Considered Excessive



Ajax Dihedral surfaces of gears provide maximum bearing area and do not tend to rupture the oil film. This contributes to long life, cool running and quiet, chatter-free operation.

* The performance of Ajax Dihedral Couplings confirms the fact that *there is no competition with quality.*

Design, installation and maintenance men are saving thousands of hours, and dollars by eliminating necessity for precision alignment of direct-connected machines.

New and exclusive Ajax Dihedral tooth shape provides for extreme misalignment with tooth clearance (backlash) kept to oil film requirements. Long life is assured because more tooth contact is maintained under operating conditions.

Positive oil seals keep lubrication in and dirt out.

Write for Bulletin 50.

AJAX FLEXIBLE COUPLING CO. INC.
WESTFIELD, NEW YORK